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Bulletin 291 June, 1918

Milk Necessary for the Nation's Welfare

IS SHE WORTH FEEDING WELL?

Bread and milk are an old combination, but we are just beginning to understand the part whole milk plays in the combination.

AGRICULTURAL EXPERIMENT STATION
OF THE UNIVERSITY OF WISCONSIN

MADISON

DIGEST

The increased price of milk leads people into making the mistake of buying less milk. Milk is the one food which nothing else can replace. Only those people who are guided by long experience or religious rites will maintain the quantity formerly purchased. Pages 3-4.

Milk is a perfect food. It contains all the factors of nutrition in adequate proportions and is an indispensable supplement to other food materials during growth. Page 4.

Energy and protein are not the only factors in an adequate diet. Animals cannot be reared on grains alone or grains supplemented with grain protein concentrates. Pellagra is one result of an improperly balanced diet. Pages 5-6.

Milk supplies adequate mineral material for rapid growth. Grains when used alone produce nutritive failure, but are changed to valuable products when supplemented with milk. Pages 7-9.

Milk furnishes the very best of proteins. Proteins are not all alike in promoting growth. Those of the grains are poor in quality, but when supplemented with milk or whey become very efficient. Pages 10-11.

Milk supplies an abundance of necessary vitamines. Butterfat is rich in the fat soluble vitamine, while plant oils contain practically none. The vitamines of cream are not injured by pasteurization. A deficiency of fat soluble vitamine may cause eye diseases. Pages 12-14.

Oleomargarine is not a complete substitute for butter. While it is a source of energy and the best grades contain some fat soluble vitamine even these do not contain as much as natural butter. Pages 16-17.

Milk is rich in the water soluble vitamine. An absence of this type of vitamine is the cause of beri beri, a disease formerly prevalent in the Orient where people lived too exclusively on polished rice and fish. Pages 17-19.

Milk is a necessity in the diet of growing children. In the absence of milk eggs are the only comparable substitute. The public must learn to appreciate, even with advancing prices, the importance of the dairy industry to the nation's welfare. Page 20.

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Milk Necessary for the Nation's Welfare

E. B. Hart and H. Steenbock

The nation is passing through a food crisis. Certain foods are scarce; many are very high in price; others can scarcely be had at any cost.

Most housewives are trying hard to find new ways of keeping down the cost of food for their families. In doing so they are trying many new foods and combinations. It is, then, of great importance that at this time the known facts concerning the nutritive values of foods be generally understood in order that the people, and particularly young children and growing boys and girls, may not suffer from improper selection of foods.

It is very necessary that we save food and avoid its waste, but it is probable that in many cases high prices may lead us to stint ourselves on certain essential foods. This condition is particularly true in reference to milk.

In the fall of 1917, even though the price of milk had not gone up so much as the prices of many other articles of food, less was used in Chicago, New York and other of our cities. In New York the Jewish mothers, who by long experience or tradition had learned the true value of this product for children, were the only class which bought and used the normal amount of milk in spite of its increased cost.

Shoes have also increased in price, but we purchase them as a necessity, grumbling though we may, but realizing that we cannot be without them. The same is true of other things that are classed as necessities. Why should we not think in the same way of milk and dairy products, so necessary for the growth of vigorous, healthy children?

No nation, so far as we know, has ever reached or maintained high virility and leadership that has not had in its diet animal products of some kind. In India, Japan, China and other parts of the far East are to be found peoples who are practically vege-

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tarians. In no case are they as vigorous or progressive as they should be. That they are able to live without dairy products is undoubtedly to be explained by their consumption of the actively growing parts of plants, especially the leaves.

MILK A PERFECT FOOD

Whole milk is a perfect food for the young. Fed by itself it will efficiently support growth. There are but few single articles of food that will do this. Eggs will do it, but cornmeal or oatmeal, for example, will not.

Animal life, after thousands of years of evolution and many trials and probable failures, finally produced in milk a food of superior quality. It, like the egg, has been developed to meet the needs of the growing young. An egg contains a potential life. The mother hen has scratched and eaten from a variety of sources, only finally to put into the egg all the food essentials needed by the unfolding chick.

Similarly the dairy cow, from her coarse and bulky feed of grain and roughage, takes the essentials, changing and improving some of them for the production of a better or more perfect food than that which she has eaten. Milk, like the egg, contains all the food needs of the growing young.

But in what respect is milk superior to other articles of food? Why is it especially important in the nutrition of all young,—whether the human baby (deprived of its natural food), the farm calf or the farm pig?

FIVE THINGS NECESSARY IN DIET

Five factors are necessary in the diet for adequate nourishment. These are a sufficient amount of energy or fuel food, an adequate supply of good proteins, sufficient suitable mineral matter, and two chemical substances of unknown character belonging to the class of materials now called vitamines. Milk is one of the few foods which contains these essential constituents in suitable proportions. In contrast, a food like cornmeal may contain all the normal factors of nutrition, but some are either too low in quantity or too poor in character to meet the needs of the growing child. Milk contains them in proportions sufficient for rapid growth and that is why it is a superior food; in fact, we use milk today as the yard stick of nutritive efficiency. In experimental work its mineral content is generally taken as a standard of excellence.

IMPORTANCE OF ENERGY

In the past and even at the present time, in discussing the nutritive value of foods emphasis has been placed upon their energy and protein content. "How many calories or heat units can be purchased for ten cents?" This side of nutrition is extremely important, for the main use of food by the adult is as a source of energy and he should know its cheapest sources. But it so happens that in such discussions of food values little or no emphasis is placed on the other factors of nutrition so important in the growth period of children. The cheapest sources of energy in foods are our common grains, such as wheat, corn, oatmeal, and rice, and these should constitute 50 to 60 per cent of the food we eat; but it must be recognized by the American public that little or no growth will take place with seeds or seed products as the sole source of nutritive elements. This fact is well illustrated in Figure 1. The mother who relies upon energy and upon protein charts as her sole guide in feeding her family and who must feed her husband and children as cheaply as possible, will be inclined to set before her family the dishes

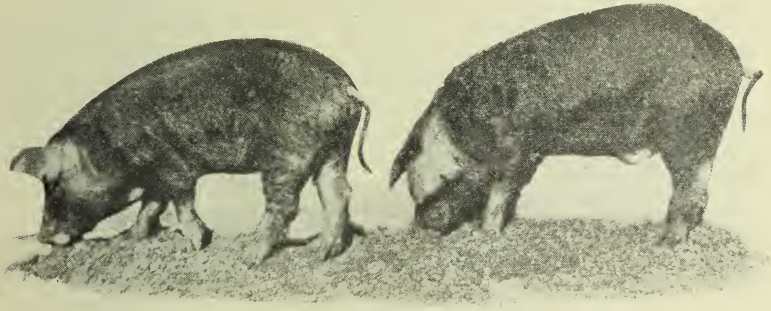

FIG. 1—FAILED TO GROW ON GRAINS ALONE

These pigs received a ration of cornmeal and gluten feed, a protein concentrate from the corn grain. Growth ceased after a few weeks on such a diet. These pigs failed to grow beyond 60 pounds because of poor mineral content and poor quality of the proteins of the ration.

prepared from cornmeal, wheat flour, rolled oats, rice, peas and beans. An excessive use of these, without properly supplementing them with materials containing an abundance of the other factors needed for growth, will lead to nutritional disturbances. The deficiencies in these seeds or seed products lie in their poor protein content, in their poor mineral content, and in their low supply of a certain class of vitamines.

At the present time, in the southern part of our country, a disease known as pellagra is found, mainly among the poor whites and negro mill hands. Its symptoms are soreness of the mouth, severe diarrhea, and an appearance of the skin closely resembling a severe burn. The cause of this disease, according to Goldberger of the United States Public Health Service, is a faulty diet. He was able to cause such a disease in normal individuals by feeding them a diet made up of cornmeal, wheat flour, rice, starch, sugar, syrup, pork fat, cabbage, collards, turnip greens, coffee, and sweet potatoes. It has been calculated that but 4 per cent of the energy of this ration came from leafy vegetables and sweet potatoes. Had this proportion been increased to 15 or 20 per cent of the diet probably this diseased condition would not have occurred; for although the rate of growth with a rapidly growing species cannot be met by such combinations alone it is possible to combine seeds and the leafy portion of plants in such a way as to supply the needs for growth.

It is just in such instances, that the supplementing power of milk comes in. We have demonstrated in numerous experiments the failure of animals when fed seeds only; but when these seeds are supplemented with milk, failure is turned into success and there is a change from suspended growth to rapid growth. Even the sugar of milk, ordinarily thought to be of no other value than as a source of energy, has special physiological properties. It is this sugar, in distinction from other sugars, that is important in holding in check putrefaction in the large intestine. This is of particular importance in the case of the infant or young child who may be very sensitive to the injurious action of abnormal substances produced in the intestinal tract. Very recently it has been shown by Mr. Pitz of this Station, that scurvy, a very old disease, may be caused by retaining an undue amount of fecal matter accompanied by putrefaction in the intestines; this has been prevented in guinea pigs by a liberal use of milk sugar.

IMPORTANCE OF MINERAL MATERIALS

The failure of animals to grow on cornmeal alone, or cornmeal supplemented with a protein concentrate like gluten feed, is primarily, but not solely, due to its low and poor mineral content. This statement is true for any of the seeds so far investigated. These facts were known many years ago by Henry, a pioneer in American feeding problems. Its poor proteins also aid to make the cornmeal diet a poor one, but its poor mineral content is its principal defect. Suppose we make mineral additions to the cornmeal-gluten feed ration in such proportions as to make the total mineral content similar to that of milk,—then what happens? We get growth at a fair rate. It will not be a maximum rate because the corn grain proteins are too poor in quality. Figure 2 beautifully illustrates such a result.

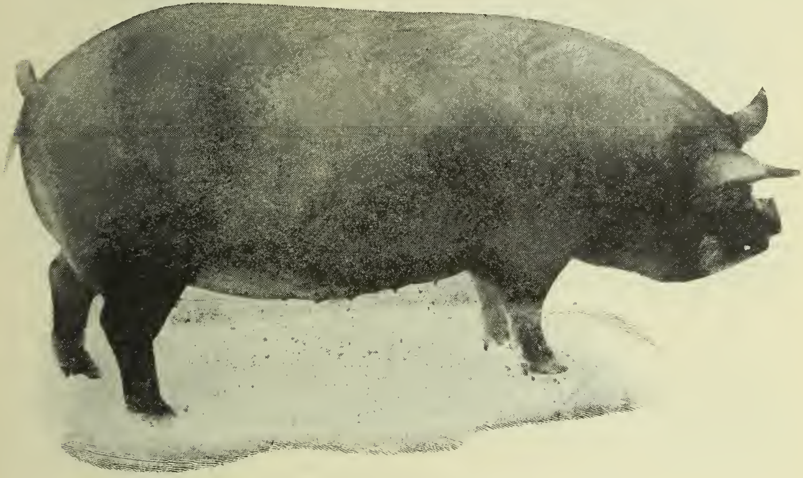

FIG. 2.—HOW MINERALS SUPPLEMENT GRAINS

The grains are all deficient in the mineral matter needed for successful growth. This pig, eventually reaching 450 pounds in weight, received a ration of cornmeal, gluten feed, common salt, potassium phosphate, and calcium lactate. It remained sound and healthy although it did not grow at the normal rate, due to poor proteins.

What applies to these animals applies equally well to children. For does any one question the fact that most of our medical knowledge has been obtained from experiments with animals? Most of the principles have first been established by carefully controlled experiments on animals. Illustrations that we submit as evidence for the various factors concerned in nutrition could not have been obtained on a human baby. The principles brought out and their importance are the same in character if not in degree.

If the cornmeal or any other grain mixture is supplemented with whole or skimmed milk, as has been demonstrated so abundantly in practice, growth at a rapid rate becomes possible. (See figures 3 and 4.) The reason for this lies in the improvement in the mineral content of the mixture and the introduction of better proteins from the milk. These matters are known in successful feeding practice, but only lately have we understood them. Once understanding comes, and the fundamental principles are laid bare, then teaching such principles can be made universal. The illustration in Figure 3 shows the effect of a grain diet alone and the grain diet supplemented with but one per cent of skimmilk; that is, one per cent of the solids of the grain ration was supplied as skimmed milk solids. Milk with its abundance of calcium and phosphorus, the main inorganic constituents of bone, makes possible a rapid skeleton development. These two elements are laid down in the bone tissue as

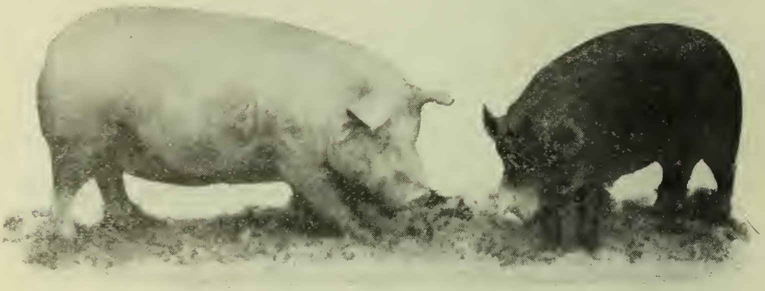

FIG. 3.—MILK SUPPLEMENTS THE GRAINS

Pigs of the same age and started at the same time. The animal on the right (100 pounds) received a ration of cornmeal, oats, middlings, and oil meal. Growth will cease sooner or later with restriction to such a ration. The animal on the left (200 pounds) received the same ration as the other, but supplemented with 1 per cent of the dry matter of the ration as milk solids. Such results need no further comment.

calcium phosphate and make it rigid and strong. It is an interesting fact that the protein, calcium and phosphorus content of milk secreted by different species or kinds of animals are in concentrations related to the rates of growth of the young of each species. A species whose young double their weight in 40 days will secrete a milk richer in protein and mineral matter than a species whose young double their weight in 80 days. Such facts as those cannot fail to show the special relation milk holds to the development of children and animals.

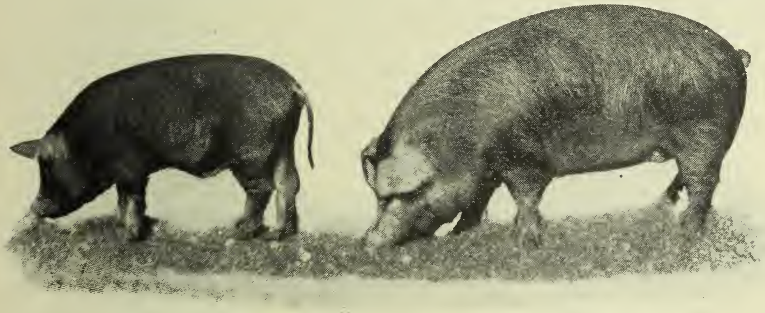

FIG. 4.—ANOTHER GRAIN AND GRAIN-MILK EFFECT

The mother of the growing boy or girl should appreciate this experiment. These pigs were of the same age and started on the rations at the same time. The animal on the left (55 pounds) received a ration of 95.5 parts of wheat meal and 2.5 parts of wheat gluten. The latter is a protein concentrate from the wheat grain. The animal on the right (165 pounds) received a ration of wheat meal and skimmilk fed in approximately the proportions of 1 : 1. It weighed 165 pounds when the other pig weighed but 55 pounds.

IMPORTANCE OF PROTEINS

We are learning that the individual members of this important class of food substances differ among themselves in nutritive value. A pound of protein from cornmeal or wheat flour is not equal to a pound of protein from milk or cheddar cheese or cottage cheese or any kind of cheese in meeting growth needs. This is probably the most important fact in a practical sense that farmers and the American public will have to recognize in the future. The building units from the proteins of our cereal grains are not so well suited as those from milk for rapid building of the protein structure of animals. It is particularly in this direction that nature did so well when through the mammary gland she constructed from the blood stream and thus indirectly from certain parts of poor proteins of the food, the proteins for the nutrition of the young.

If the cereal grain proteins are used as the sole source of protein for the growing animal they will show an efficiency of less than 30 per cent, while the proteins from milk will reach an efficiency of 65 per cent. In other words, while only 30 per cent of a pound of proteins from the corn kernel would be stored away, 65 per cent of a pound from milk would be stored by the growing animal. In storing the 30 per cent of proteins from the cereal grains 70 per cent will be wasted, because it does not fit well into the growing structure of the young; but only 35 per cent of the milk proteins will be wasted.

However, when corn and milk are used together what a wonderful relation is revealed. The milk proteins now fit into the cereal proteins in such a way that 60 to 65 per cent of the total mixture is retained. This is real conservation. The poor proteins of corn have been brought to a higher utilization and instead of 70 per cent being wasted when fed alone to a young animal, but half that amount is wasted.

It does not take much imagination to translate this process to the growing boy and girl. With their cereal breakfast food covered with whole milk they are using the proteins of the milk and at the same time are making better use of the proteins of the breakfast food. They are meeting their growth needs and are developing into the strong men and women the nation needs.

Even the small amount of proteins in whey supplements the cereal grains in a most effective way. We have conducted experiments with growing pigs where this cheese making by-product has been used at the rate of four pounds daily, supplemented with cornmeal and gluten feed. Although when the grain mixture was used alone less than 30 per cent of the proteins was kept, 47 per cent of the proteins of the whey-gluten feed-cornmeal mixture was saved; yet the whey proteins constituted but 16 per cent of the entire protein mixture. What a saving of the cereal grain proteins this would mean when properly applied. Yet in the summer of 1917 we found the proprietor of a cheese factory in the northern part of Wisconsin dumping the whey into the wood lot. This should all have been saved and returned to the farm, and fed to the stock.

A pound of cottage cheese contains as much protein as a pound of meat and the proteins of this product are as good as those of meat; true, the meat probably contains some stomach and intestine stimulating materials of considerable value, but surely the splendid food, cottage cheese, as well as other varieties of cheese should be used to spare some of the meat now so excessively used by the American public. Figure 5 illustrates these variations in the nutritive value of proteins and the remarkable supplementing power of milk and whey in improving the efficiency of cereal grain proteins.

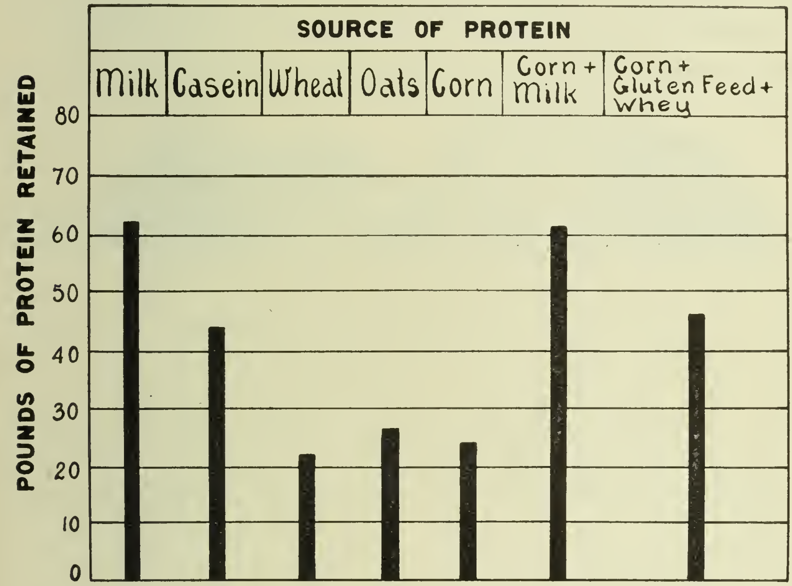

FIG. 5.—DIFFERENCES IN THE NUTRITIVE EFFICIENCY OF PROTEINS

This chart shows the number of pounds of protein which a pig can retain for growth from each 100 pounds of protein consumed, when the proteins are derived from the different sources indicated.

Such facts as these are very significant and make it clear why milk in any form, whole, skimmed, or as butter milk, or in the manufactured products, becomes a superior article in the ration of growing animals or for human consumption. The mother who keeps whole milk in the diet of the growing boy or girl, or the milk products manufacturer who makes clean, wholesome skimmilk, buttermilk, or cheese available for human consumption will aid measurably in making stronger boys and girls and help ward off the dangers of under nutrition among the children of the cities.

The consuming public must clearly appreciate these facts even if the prices of dairy products advance. No industry can be maintained permanently that is not profitable and that operates at a financial loss. It would be a calamity to coming generations should a situation develop in this country that would lower the production of dairy products because of decreased consumption. Occasionally a child cannot tolerate milk or milk products in any form; but such cases are rare. When they occur the only real substitute will be found in eggs. Meats are less efficient because of their poorer mineral and vitamine content. We have known weak, growing children made strong by the use of whole milk and eggs; always with improved nutrition there comes a greater resistance to disease.

IMPORTANCE OF VITAMINES—THE FAT SOLUBLE TYPE

Vitamines are as yet unidentified chemical substances in foods, and are absolutely necessary for growth and reproduction. Without them no growth will take place. They are abundant in milk and eggs and in the leafy portion of plants. One class which can be dissolved in water is abundant in seeds, while another class, dissolved in fat, is apparently not so abundant in seeds. Both classes are abundant in whole milk. The discovery of the vitamines in milk was first made by Dr. F. G. Hopkins of Cambridge, England. They were separated into two classes by McCollum. The fat soluble vitamine of butter was recognized independently and at the same time by Osborne and Mendel of Yale and by McCollum of this station.

A number of years ago chemists, and first among them, Hopkins, tried to get young animals to grow on rations which were made up of mixtures of carefully purified proteins, carbohydrates, fats and salt mixtures (mineral materials) from the chemical laboratory. These salt mixtures must contain all the elements which are left as ash when the body of the animal is burned and include iron, iodine, potassium, sodium, calcium, magnesium, sulphur, phosphorus and chlorine. When such rations were fed, the animals not only did not grow, but they did not live any length of time, not over two months. The essential thing to remember about these experiments is that the foods used were highly purified.

If we take such a mixture of food stuffs which do not allow an animal to grow and stir into it a small quantity of egg yolk, say for a pound of the ration an ounce of egg yolk, growth can be induced. The same result would be obtained if we had put in an ounce of evaporated milk instead of the egg yolk. Suppose next that we take all the fat out of this satisfactory ration by extracting it with something that dissolves fats. It will be found that though the ration will be able to maintain young rats without any increase in weight for about a month, it will no longer be able to induce growth. Only on restoring the extracted fats to the ration will growth be made. A similar result could have been obtained by adding butterfat or fats obtained from certain animal organs; but other fats such as lard, almond oil and cottonseed oil would not have brought about the same result.

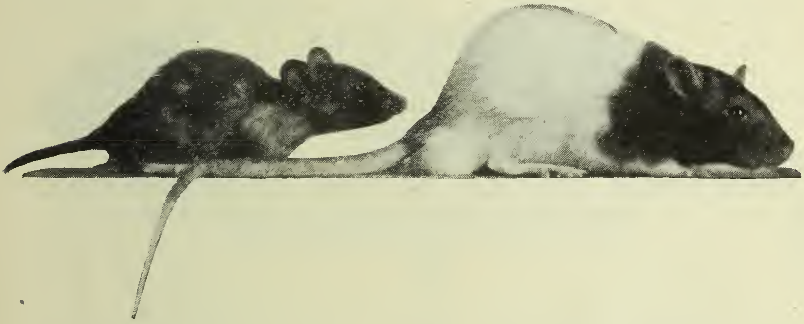

FIG. 6.—PLANT OILS DEFICIENT IN FAT SOLUBLE VITAMINE

The rat on the left received 5 per cent of cottonseed oil and the one on the right 1.5 per cent of butterfat instead of cottonseed oil; otherwise the rations were alike and the rats were of the same age. The plant oils lack the fat soluble vitamine without which growth cannot proceed; yet this vitamine is contained abundantly in whole milk, eggs, and the leafy portion of plants.

These facts might well cause us to stop and think. Because of the fact that some fats naturally contain substances necessary for growth while other fats do not contain such substances, there has arisen the necessity of speaking of the presence or absence of a fat soluble vitamine. This vitamine is closely, though not exclusively, associated with fats. It is also found in seeds to a certain extent, and the leafy portion of plants to a considerable extent also contains this substance. Milk, eggs, and alfalfa leaves are a very good source of this unknown constituent, although there is every reason to suppose that forage plants in general are a better source of this class of vitamines than the grains.

The fact that the fat soluble vitamine of milk is concentrated in the fat of this product might lead to the inference that skimmilk would be inadequately provided with this substance. It is evident, however, that a portion of the vitamine contained in the milk fats dissolves in the whey of milk and consequently is present even in skimmilk, although perhaps not as abundantly as we should wish.

Of late there has appeared in the advertising literature of manufacturers of milk-product substitutes the statement that the vitamines of milk are destroyed by pasteurization. *This statement is absolutely false.* In our experiments in the study of the vitamines, butterfat is heated higher than is required for pasteurization and for much longer periods of time without destroying this substance.

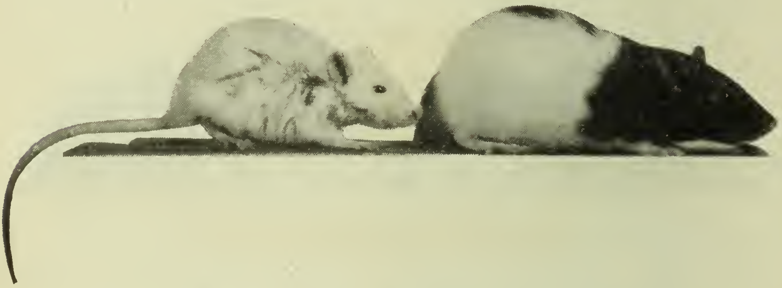

FIG. 7.—HOW FAT SOLUBLE VITAMINE EFFECTS GROWTH

These two rats ate the same food mixture, except that the one on the right received a small amount of butterfat and the one on the left in place of the butterfat an allowance of sunflower seed oil. They were the same age. Apparently there is no oil of plant origin which will take the place of butterfat, egg fat or certain other fats of animal origin. The leaves of plants such as clover, alfalfa, and probably other leafy plants supply the ingredient which gives butterfat its peculiar growth-promoting property. The vitamine of butterfat is also found in seeds, but probably is not as abundant there as in the leafy part of the plant.

Further, there is in these times of food scarcity a tendency to use plant oils as substitutes for butterfat, even claiming for them a value equal to that of butterfat. No plant oils so far investigated, and those include cottonseed oil, almond oil, peanut oil, cocoanut oil, and sunflower seed oil, contain the fat soluble vitamine in appreciable quantities. It is false to claim these as substitutes for butterfat. We do not condemn them, for they are valuable food products as sources of energy and their use for that purpose should be encouraged; but they should sail under their own banner and be used in nutrition for exactly what they are worth. To remove the butterfat from whole milk and replace it with cocoanut oil and then claim that the product is equal to whole milk for the nutrition of growing children is not true.

In the dairymen's competition with butter substitutes a word should be said concerning oleomargarine. This product is made from both plant and animal oils and the higher grades are churned with milk or butter or both. The plant oils used contribute no fat soluble vitamine; the neutral oil, or that pressed from lard, contains no fat soluble vitamine. The oleo oil, or that prepared from beef fats, does contain some of this type of vitamines and of course the milk products contribute another portion. The result is that the finished oleomargarine contains some of this vitamine, but it is necessarily not in the same concentration as found in the natural butter. Their dilution, as compared with butterfat, is in proportion to the plant oils and neutral oil used, with a further dilution by the use of oleo oil which contains this substance in less concentration than does butter. Consequently, even the higher grades of oleomargarine will have their fat soluble vitamine content diluted, the degree

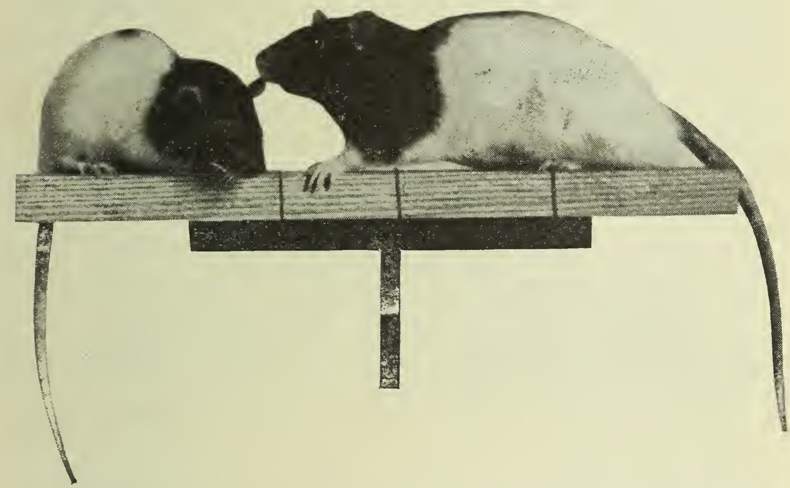

FIG. 8.—THE EFFECT OF A DEFICIENCY OF THE FAT SOLUBLE VITAMINE

Two rats of the same age and same sex. The rat on the left received as its source of the fat soluble vitamine 5 per cent of the ration from a so-called butter substitute, while the rat on the right received as the source of this fat soluble vitamine 5 per cent of the ration as butterfat. Note the small size (109 grams) and sore and infected eyes of the rat on the left as compared with the vigorous condition, bright eyes and larger size (262 grams) of the rat on the right.

of dilution depending upon the method of manufacture. Five per cent of butterfat in a ration of purified food materials contributes enough fat soluble vitamine for normal growth, but 5 per cent of the oleomargarine we have tested will not accomplish this. These are the facts as they are known today, and they should make it clear that no product can claim the distinction of substitute unless it shows equal nutritive value in quantitative relations. These facts do not condemn oleomargarine any more than they condemn plant oils, but merely disclose what each contributes to nutrition.

In the mixed diet of mature men it undoubtedly is possible, by the proper selection of foods, to meet the body needs for the fat soluble vitamine from sources other than dairy products, but we cannot afford in the present state of our knowledge to advocate that growing boys and girls, and mothers should economize in respect to adequate nutritive factors by using substitutes that do not substitute. (See figures 6, 7 and 8.)

With inadequate supplies of the fat-soluble vitamine in the diet a serious form of malnutrition has been observed. In some experimental animals deprived of this growth promoting substance for a period of months during the growing period, there occurs a swelling of the eyelids and marked inflammation of the eyes. If the faulty diet continues, blindness will result and eventually death. This dietary deficiency disease is now called xeropthalmia. Recovery can be effected if the fat soluble vitamine is replaced in the diet by the addition of butterfat before the disease has progressed too far. Cases of this nature have been reported from time to time as occurring among Philippine children living on a vegetarian diet, especially during a period of drought and when fresh vegetables were scarce or unobtainable. A Japanese physician, Mori, recognized that animal organs, such as chicken livers, would cure the disease when added to the diet of these children. It is now known that the fats of the kidney and the liver contain the same vitamine as does butterfat. Bloch, a Danish physician, has also recently reported the occurrence in the rural districts near Copenhagen of the same trouble among children who had been fed exclusively on a diet of separator skimmed milk. Both Bloch and Mori consider the disease as a fat starvation, but as pointed out by Monrad it is probable that we are dealing here with a vitamine deficiency, since Bloch reports that there was immediate recovery when whole milk was given these children. Figure 8 shows the effect on a growing rat of a deficiency of the fat soluble vitamine and its relation to eye infection.

IMPORTANCE OF THE WATER SOLUBLE VITAMINE

Besides the fat soluble vitamine we have still another class to consider. Suppose that to our unsatisfactory ration of proteins, carbohydrates and salts there is added the egg yolk *fat* or butter *fat;* we will find that the ration will still be unsatisfactory. If next we make a water extract of the egg yolk from which the fat has been previously removed and add this to our ration, growth will be renewed promptly. It was not, then, the addition of fats alone or of substances carried by them that caused renewal of growth when untreated egg yolk was added, but it was the addition of the fat soluble vitamine and water-soluble vitamine. Both are indispensable for growth. Like the fat soluble vitamine the water-soluble vitamine can be obtained from various sources. It is found in abundance in milk, eggs, grains, and the leafy portion of plants, from which it can be readily extracted with water. It is not present in starch, sugar and fats and is found only to a very limited extent in polished rice. The

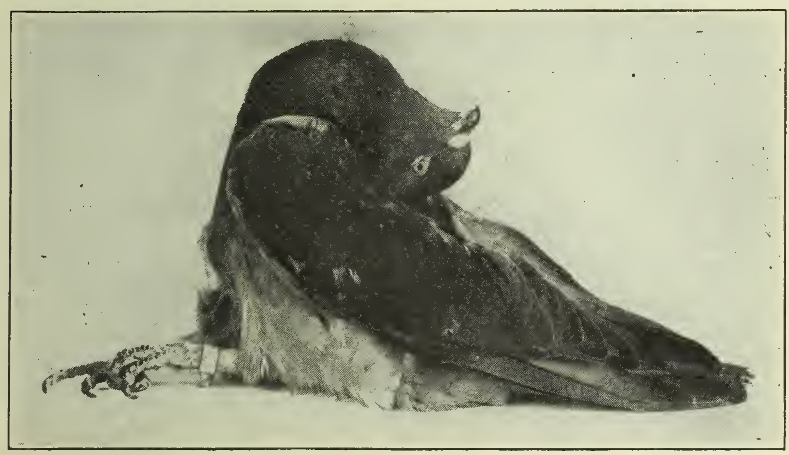

FIG. 9.—EFFECT OF A DEFICIENCY OF WATER SOLUBLE VITAMINE

A pigeon showing a neck spasm in an acute attack of avian beriberi (polyneuritis) resulting from the consumption of a ration of polished rice which is deficient in the water soluble vitamine.

fact that this vitamine occurs in insufficient amount in polished rice and fish has lead to an explanation of a widely occurring disease among certain classes of people in China, India, Japan and the Philippines, who have lived largely on these two products. These people suffer from a disease called beri-beri, the

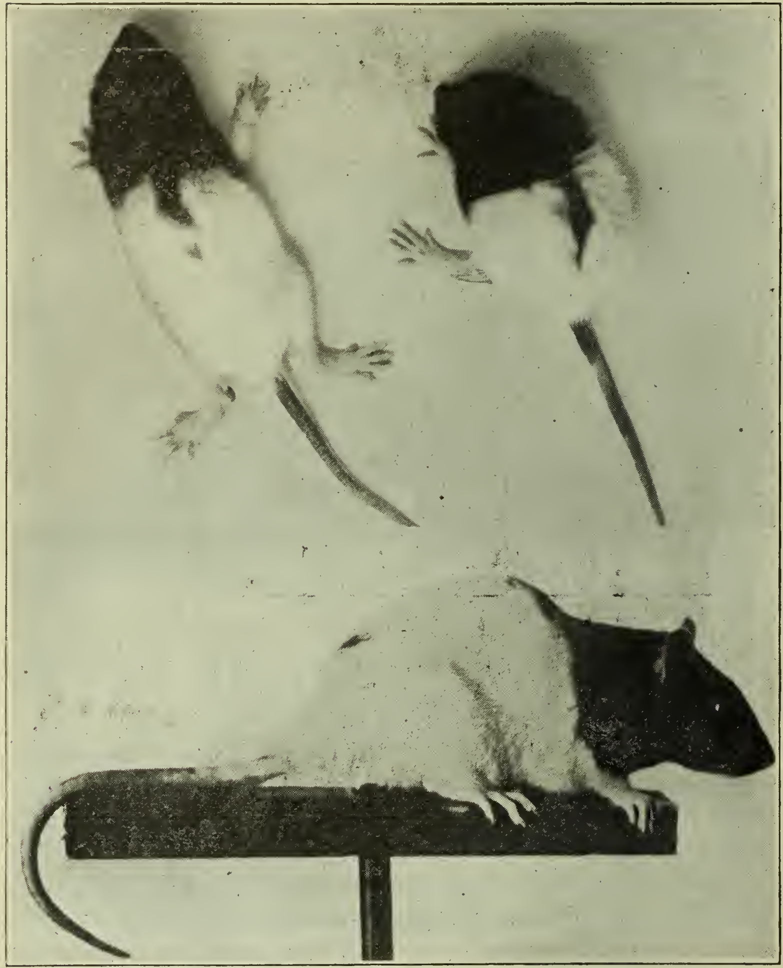

FIG. 10.—EFFECT ON OFFSPRING OF A DEFICIENCY OF WATER SOLUBLE VITAMINE

This rat received as natural food but 10 per cent of the ration as barley grain. The rest of the ration was from purified materials. The supply of water soluble vitamine was sufficient for her own maintenance, but not enough for both herself and an abundant supply in the milk. The young show the effect of this shortage. They grew rapidly for a time, but suddenly lost weight sharply and showed periods of great excitability. They had a rolling gait and often suffered from convulsions. This class of vitamines is abundant in milk as normally produced from natural foods and is also abundant in eggs, seeds, and the leafy and stem portions of plants.

most prominent symptom of which is a general paralysis caused by the degeneration of the nerve cells. Only those who eat too abundantly of rice after it is polished suffer from this disease. The cause of this is found in the removal of the germ of the rice kernel, for it is in this part of the seed that the water-soluble vitamine is mainly located. In polishing, both the bran layer and the germ are rubbed off and the polished rice behaves in the nutrition of the animal just as does a mixture of purified proteins, starch, and a mineral salt mixture. Polished rice will not support life for a very long period, much less induce growth in the young. This type of vitamine is abundant in milk, eggs, seeds and the leafy portion of plants, from which it can be readily extracted with water. Figures 9 and 10 show the effect of its absence from the diet.

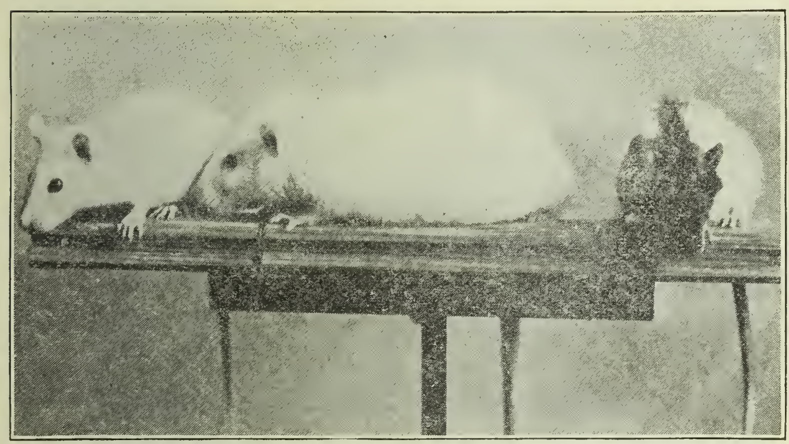

FIG. 11.—EFFECT OF AN IMPROPER BALANCE OF DIET

On the left, too low a mineral content; center, proper balance of factors; right, too low a protein content. These rats are of the same sex and age, but received different rations from the time that they were weaned until the above picture was taken. Their final weights were respectively 63, 211, and 47 grams.

There appears to be much less danger to the public welfare of this country from a deficiency of the water-soluble type of vitamine because of its generous occurrence and wide distribution, and the general use of a mixed diet.

It should be made plain again that neither class of vitamines is constructed by the animal. The dairy cow concentrates them from the feed and places them in the milk. This generous and significant act entitles her to the name, "The foster mother of the human race."

MILK A NECESSITY IN THE DIET

The facts concerning the nutritive value of whole milk and its products presented in the foregoing pages should emphasize in no uncertain way the great necessity on the part of the purchasing public of realizing the important place the dairy industry should occupy in the life of this nation. With an increase in the price of cereal grains, grain by-products, and other feeds consumed by the cow, combined with an increase in the cost of farm labor, there can be no other result than an increase in the price of milk and dairy products if many of the milk producers are to continue in business. Even at a price above what any of us are now paying milk is one of the cheapest sources of nourishment.

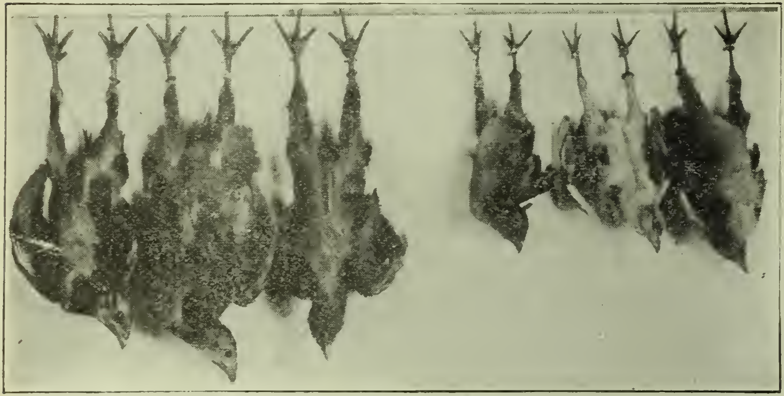

FIG. 12.—HOW THE GOOD PROTEINS OF MILK INFLUENCE GROWTH

Corn and clover or wheat and clover are not deficient in energy, minerals or vitamines, but the protein mixture is not as good as when milk is added. This picture illustrates what Professor Halpin of this Station has done with baby chicks of the same hatch. Those on the right received corn and fresh green clover; those on the left were given corn, clover and skimmilk. The average weight at the same age was respectively 84 grams and 260 grams.

Milk is worth more than its energy value; it is the great factor of safety as a supplement to our grains and makes good their deficiencies. It should be used not only liberally in the feeding of children, but in our cookery as the common and efficient assistant of our diet.

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Price-Fixing and the Cost of Farm Products

H. C. TAYLOR

ONE OF THE FIRST PRICE-FIXING COMMISSIONS

The Wisconsin Milk Commission of October, 1917, in conference with all parties concerned, settled upon the price of milk for the Chicago-Milwaukee district.

AGRICULTURAL EXPERIMENT STATION
OF THE UNIVERSITY OF WISCONSIN

MADISON

DIGEST

The demand for price regulation has increased rapidly during the past year. Cost of production is assumed to be the basis of this regulation, but there has been much difficulty in the application of the cost principle to price-fixing. Pages 3–4

Costs vary greatly from farm to farm. To fix prices on the basis of average costs would leave about half the farmers producing at a loss. There are differences of opinion as to whether produced feeds should be charged at cost of production or the market price. Pages 4–6

It is difficult to distribute cost of production. Much of the expense would be the same if one crop in a rotation were dropped; hence the specific cost of a given crop cannot be used as a basis of price-fixing. Pages 6–8

Total farm profit is recommended as the starting point in price-fixing. The combined prices of the group of crops produced on one farm must be enough to make the given type of farming profitable. For example, if the milk price is continually held too low, farmers may find total farm products greater in the production of beef or wool, in which less labor and cheaper feeds are required. Where there are competing crops such as barley, oats, and wheat from which the farmer may choose, the price of wheat cannot be held down while the others are high without danger of reduction in the seeding of wheat. Pages 8–12

A bad system of price regulation may do untold damage by destroying agricultural industries which have required decades to build. The long-time point of view is necessary and should be considered by price commissioners, producers, and consumers. Pages 12–14

Price commissions should make a careful study of the demands for consumption at the various possible prices, and then carefully study the conditions of production to find what supplies can be produced profitably at the various prices and adjust them with a view to keeping supply and demand balanced. Pages 14–15

A price commission might well act as a medium for collective bargaining in the sale of farm products and in the purchase of supplies. It could steady prices, guide production, and in a measure, direct consumption so that the greatest good might result to all concerned. Pages 15–16

Price-Fixing and the Cost of Farm Products

Many who in the past have been satisfied to leave the fixing of prices of farm products entirely to competitive forces operating under the law of supply and demand now see the need of commissions to adjust prices. The Price Commission, to be successful, cannot represent a class, but must stand for economic justice to all classes. The condition and needs of the producer, the distributor, and the consumer must be considered with equal care. The biggest problem in price-fixing is to get the facts needed as the basis of action.

For many years the idea of price control has received the attention of farmers who have been hard pressed to make both ends meet. Dollar wheat sounds cheap now, but at one time it looked like a cure-all for the ills of the Dakota farmers. The control of cotton prices has often been talked about in times of low prices, and the price of Burley tobacco was more than doubled by the concerted action of farmers in holding their product and refraining from growing a crop in 1908. In all this agitation it was argued that the price should be enough to pay the cost of production and a reasonable profit. This point of view stimulated interest in farm cost accounting as a basis for price-fixing.

The United States Department of Agriculture and many state experiment stations have cooperated with farmers in keeping detailed records of man and horse labor, the use of equipment, and other elements of costs, as well as the yield, in quantity and value, of each kind of product. Occasionally a farmer has undertaken detailed records on his own initiative and without official aid, but the amount of clerical work in keeping a complete system of cost accounts is more than most farmers have time to do.

In the official promotion of farm cost accounting, the purpose has not always been well defined; but there have been at least two points of view. A position taken by many who are interested in the marketing problem is that costs should be known in order that they may be used as a basis of price-fixing. A view held by men interested in the problems of farm management is that cost accounts show the relative profitableness of competing crops and livestock enterprises, and hence give the starting point for scientific farm management.

It would seem that the Federal Food Administration in fixing the price of wheat, and the Chicago Federal Milk Commission in its work of the past winter, assumed that cost of production is the foundation of price-fixing, yet when these officials have approached the final problem of price-fixing, they have found themselves confronted with unexpected difficulties.

Why all this difficulty in the use of cost accounts as a basis of price-fixing? There are doubtless many reasons, but there are three of unusual importance. First, variation in costs; second, joint costs; and third, disagreement in the elements of costs. But in spite of these difficulties, accounting may be used in price control.

VARIATION IN COSTS

There is a very wide range in the cost figures which have been secured by careful methods of accounting and there are wide ranges in the estimates of costs of different producers. On the basis of a farm management survey made on 51 farms in one dairy district in Wisconsin, the return per dollar of annual outlay ranged from 77 cents to $3.05. The results of the Wisconsin Dairy Cow Competition carried on in 1909–11 illustrated this point. The return per dollar's worth of feed consumed by the 398 cows in this contest varied from 92 cents to $2.71; the average of the best ten was $2.38 worth of product per dollar's worth of feed and the average of the poorest ten was $1.11.

With wide ranges in the costs of production, which cost shall be accepted as the basis of price-fixing? The average has been seriously suggested but abandoned in disgust when it has been realized that a price fixed on the basis of average costs would probably result in a loss on half the farms.

The marginal or greatest costs have also been suggested. Economists have a theory that prices tend to equal marginal costs; this is thought to be true because it is assumed that the man who is producing at a loss will drop out, or, if the supply is short the price will rise to the point attracting others less favorably situated to enter the same line of production and thus keep the price and the greatest cost tending to equal, though at any given time they might be far apart. There seems to be some relation, therefore, between the highest cost necessary to produce a given supply and the price which in the long run will have to be paid in order to get the supply.

DISAGREEMENTS REGARDING THE ELEMENTS OF COST

The price at which to charge the supplies which have been produced upon the farm, presents further difficulties in the efforts to determine costs. Shall feeds be charged at cost of production or at market price? In calculating the cost of a 1918 corn crop, should the seed corn be charged at the cost of production or at the market price? A similar question arises with respect to seed potatoes. In figuring the cost of milk the question arises: Should the hay, the oats, and the corn produced on the farm be charged on the basis of cost of production or at the market price? There seems to be an accepted rule of accounting which gives definite directions to charge all the produced supplies at cost and not at market price. On the other hand, farm cost accountants connected with the United States Department of Agriculture and the various experiment stations have quite generally charged these produced supplies at market price minus the cost of delivering them to the market.

A few years ago when the point of view was that of proving that dairying was profitable and an industry which should be stimulated by the press in every way possible, one agricultural paper held tenaciously to the old accounting rule of charging feed to the cows at cost of production because this magnified the profits of dairying by throwing the field profits into the dairy account. Now that the point of view has changed and the price of milk is looked upon as the objective point in cow cost accounting, this same paper is definitely of the opinion that produced feeds should be charged to the cows on the basis of market price. It is not difficult therefore to understand why there should have been two opinions, on this point, before the Chicago Milk Commission. Each party accepts the rule of accounting which best serves his interest.

If there were two methods of testing the amount of butter fat in milk, one of which favored the farmer and the other the purchaser, this same alignment of the interests would doubtless be formed. Fortunately there is one accurate fat test accepted by all, hence this occasion of trouble is avoided. What is needed to settle this question in accounting is one correct rule based upon the ecomonic principles underlying the case. Obviously both of the opposed rules cannot be based upon a sound foundation; hence arises the question, Is either rule correct? If not, how can the correct principle be discovered? It is believed that the true solution of this problem lies in the substitution of total farm profits for specific costs as a basis of price regulation.

JOINT COSTS

The typical farm provides a much more difficult accounting problem than a saw-mill, a flour-mill, a cotton-mill or a steel-mill. The problem is more nearly comparable to that in railway accounting, where one expenditure affects a great number of sources of income. The farmer who produces but one crop is rare. On the typical dairy farm, corn, small grain, clover hay, and pasture, cattle, horses, and hogs are all produced. The same plows, harrows, and horses are used for the various crops which require attention at different seasons and the same laborers are used for crops and livestock. When the corn is being cultivated the corn is not only benefited but the land is being put into better condition for the small grain crop which will be grown the next year. When the land is prepared for small grain the seed-bed for the clover is being prepared, and oats or barley serves as a nurse crop for the clover plant which in turn is able to draw upon the nitrogen of the air and provide plant food needed for its own growth and for the corn crop which is to follow. Hence the costs of these three crops are said to be joint costs.

Under these circumstances, suppose it is found that the oat crop costs more than the market price, that the cost of oats is ten cents greater than the price. What can the farmer do about it? He can do a little figuring to see whether or not another crop which requires his attention at the same periods and which serves equally well as a nurse crop, barley for example, can be substituted with a profit or with a smaller loss. If not, should the farmer cut out the small grain crop? Usually not. The total cost of man and horse labor would be reduced little by omitting the oat crop because oats and corn require labor at different seasons and are supplementary to each other. If this crop were not grown the hours of productive labor would probably be reduced and the average charge per hour for labor applied to the corn would be greater.

But this is not all. Oats are used as a nurse crop for clover, and while it may be possible to grow clover without a nurse crop, this would cost nearly as much as putting in the oats. Hence the growing of small grain is usually the cheapest way to get a seeding of clover and where clover thrives this is the best way to secure nitrogen for the corn crop. Thus it is the joint results of the joint costs which are important.

Having adopted the system of farming, the parts of it should be adhered to so long as the system as a whole continues to be attractive, and so long as each part of the system continues to pay better than the substitute which is competing for a place in the system.

The corn, oats, and clover combination is not a complete system of farming in itself. It is usually combined with one or more livestock enterprises. Beef cattle and hogs, dairy cattle and hogs, or straight dairying may be combined with this cropping system. In each of these systems there are many instances of joint costs. The joint cost of fattening steers and hogs is commonly understood among feeders. Where butter fat and pigs and veal calves are the products sold, these three products have elements of joint cost. Where purebred cattle and milk are sold the costs are joint and inseparable; the important question relates to the profit of the system as a whole.

Where grade cows are purchased and used for the production of city milk we approach more nearly to a specific cost of a specific product as far as the livestock industry is concerned, with only a small by-product in the form of a veal calf. And yet this type of dairying has its costs intermixed with the system of cropping, notably in the use of labor, the use of crops, and the provision of fertilizer. Hence, in mixed farming, joint costs are present to block the effort to arrive at the cost of producing any specific farm product.

Where two articles are produced as a result of the same work the combined prices of the two tend to equal the greatest necessary cost of producing them, but the price of each article is determined separately on the basis of supply and demand.

Consumers want a variety of things produced by the farmer. How much a consumer will pay for a given article depends upon the intensity of his desire for it. The intensity of this desire depends upon how abundantly he has been supplied. The more he takes the less he will pay for any given unit of the goods. Unfortunately, under conditions of joint costs there are certain physical facts which determine the ratios in which goods are produced, without much regard to the ratios of the intensity of the desire for them. As a result the supply-demand price of one product may be higher and that of another lower than the cost, but the combination of crops may prove profitable. The case is similar to the situation in the oil business. Gasoline and kerosene have a joint cost; and it is the condition of the market and the relative proportion in which they are obtainable at a common cost which makes the price of gasoline nearly twice as high as that of kerosene at the present time.

TOTAL FARM PROFITS AND PRICE REGULATION

When the point of view of total farm profits is accepted by the price commissioner the problem becomes that of so regulating prices that the farmer in one line of production may reap as large a reward as he could earn producing some other product, or else of helping him in getting into some other line of production. By looking to total farm profits he avoids many of the difficulties arising out of differences in the costs of producing a given article by different men. Even if it costs one man 2 cents a quart to produce milk, another 3 cents, another 4 cents, and still another 5 cents a quart in a given city milk belt, yet each of these men may be doing the type of farming which pays him best and the industry may be stable so long as relative prices remain the same. Likewise the question of joint costs is avoided, for it is no longer a question of the cost of a specific product, but of comparing the total farm profits resulting from the various types of farming and from the different competing elements in each kind of farming. Furthermore, the question of charging feed at market price or cost of production would seem to pass with the effort to find specific costs. However, something akin to this latter remains. The farmer may compare the profits he would make if he sold his corn, oats and hay at present market prices instead of feeding them to cows and selling milk. In this he should not assume that if the community turned from milk selling to crop selling that the prices of all these crops would be what they were before the change, neither should he assume that his crops would yield the same if he changed to grain growing for the market. Oats and corn are used directly for human food and have many other uses and are so easily shipped that there would continue to be a market for them, if not used as cow feed; but clover hay is a stock food and it is not so easily marketed. The important alternative uses for clover if not used for cows are (1) to feed to beef cattle, (2) to sheep, or (3) to plow under as a fertilizer, any of which conserves its value as a land-builder as a basis for grain growing. Where clover has entered into commerce it has usually been as a feed for dairy cows. When discarded for this use, therefore, the marketing of clover hay could not be counted upon. A farmer in the Chicago milk district insists at this moment that it pays better to sell grains and plow the clover under than to make clover hay and feed it to livestock. He is practicing this system now and is satisfied. In this and similar cases it is the alternative use value rather than cost or present market price which becomes the basis of comparing the profits of types of farming, and hence the basis of choice.

This means that formally assigned specific costs are of little use in the discussion of price-fixing. It does not mean however that cost accounting is of no use in the study of this problem; in fact, accounts are very necessary, but in a different way from what has been supposed. Accounts are useful to the farmer in making choice of crops and live stock enterprises and his methods of production. Accounts are useful to the price commissioner in estimating the price necessary to call out continuously the desired supply of produce of a given kind and of suitable quality. For these purposes specific costs may not be needed. What are needed are figures comparing the profitableness of the different things to which the producer can turn his attention. The alert farmer is ever figuring on the combination of crop and livestock production which will pay him best with a given price schedule and with given costs for land, labor, and equipments.

When the point of view in farm cost accounting is shifted from specific costs to comparison of profits the whole problem is much simplified. In the attempt to secure specific costs, accounts had to be kept in minute detail comprehending every activity and economic relation of the farm. As soon as one shifts to the point of view of comparing the profits of competing enterprises, no record need be kept unless the farmer really has a choice and then only such records as are essential to answering the question, Does this pay better than that? For example, the farmer in southern Wisconsin has a choice between growing oats and barley. In order to make a wise choice on this point it is not necessary to know the specific cost of growing either oats or barley. All that is necessary is to know differences in costs and differences in the value of the crops. In this case the same tools, machinery, horses and men are used at essentially the same time of year whether the farmer grows the one crop or the other. These common items of cost may be omitted for they cancel each other in the calculation. When put in this form the question is so simple that almost any farmer can figure it out on the basis of such facts as are easily available by keeping a production record and by studying price quotations.

The milk producer has a number of ways of disposing of his product. He may sell whole milk to a city, or a condensery. He may take his milk to a cheese factory and carry home the whey or he may separate the cream and sell it for city use or to a butter factory. If the milk is marketed through the cheese factory, hog production is introduced as a supplementary industry using the whey. If he sells cream, calf raising and pork production may be combined with dairying as a means of using the skimmilk. All of these different types of dairying can be based upon the corn, oats, hay, cropping system. The combination a given farmer should choose depends upon which pays best under his particular conditions of production and marketing.

The dairy farmer has, of course, other alternatives. He can change from dairying to beef and pork production, based upon the same field crops. Again, he can abandon cattle and hogs entirely, grow grain to sell and raise horses as a side-line to use up much of the unsalable roughage, but in figuring the merits of this last system, influence upon fertility and production of grain per acre should not be ignored. He has the further alternative of trying his fortune in the city, and this horn of the dilemma has frequently been the choice.

With all these opportunities before him, the farmers are slow to shift from one thing to another in normal times because, for a given community, the question of what pays best becomes fairly well settled. Near the cities, whole milk of high quality is produced under sanitary conditions of a higher standard than in other dairy regions. Outside of the milk zone there are scattering cream shippers selected mainly with respect to the characters of the farmers participating. These are intermingled with the farmers producing for the creameries and cheese factories. The city milk zone becomes more or less well defined with the boundary line moving out a little farther in winter and contracting in summer, with a gradual expansion of the milk zone about a growing city.

But in abnormal times when radical changes are taking place in the prices of all these competing lines of production, farmers with their eyes upon the market become uneasy and unsettled in their convictions as to what to produce. The fact that the producer of city milk is getting more than he ever got before is not a sufficient consolation if he might be making more profits selling grain, hogs, and butter fat, in spite of the fact that he has gone to greater expense to equip his farm for meeting the requirements of the city ordinances. It is this unsettled condition which has given rise to the recent efforts to regulate prices.

In deciding upon a fair price to the farmer on the part of a commission the alternative choices of the farmer become the basis for a rational decision. The industry should be made attractive to the farmer if he is expected to remain in it. But what is essential to make a given system of farming attractive? Must it pay some definite labor income to each farmer engaged in it? Apparently not, for as a matter of fact men are remaining in each type of farming who are making small incomes while others are making very large incomes.

Whether or not a man should continue to carry on a given type of farming depends upon his opportunities in other lines of farming or other lines than farming. If there is no better outlook, if he is doing better than he could do any place else, he will probably continue to produce the supply for the price he can get and look to methods of reducing costs as a means of increasing profits. If there is an alternative which will pay him much better, which should he do, ask that his price be lifted to the point where his present activities will pay as well as the alternative or quietly choose the better paying activity? The answer is not so obvious as it might at first appear. Shifting is often expensive and there is usually hope that conditions will change and the old line will again pay better. It often takes a generation to build up a type of farming, and when the system becomes unprofitable a serious loss is suffered before readjustment can be made. Yet where permanent changes in market conditions have come about, changes in farming are necessary. Where readjustments should be made it is believed that public expenditures to aid in the readjustment, especially by means of educational campaigns, may often be more desirable than price lifting as a means of making the industry profitable.

Here is work for price commissioners well trained in agricultural economics, who will ascertain the true cause of price changes, make a study of the conditions of production, and advise the farmers in making readjustments in their farm management or in standing by their old lines of production as the case may warrant. In this work the price commissioner should not forget that the well-being of the farmer is just as important as that of the consumer, and that in the long run prices should be such as will make farm work and country life attractive.

In carrying out this policy, price lifting may at times prove desirable. This is most likely to happen in case of articles like milk for which the price is more or less influenced by custom and which is often sold at the same price for long periods and which for this reason does not adjust itself quickly enough in times of radical changes in the general price level; but wherever isolated farmers in great numbers are acting individually in selling their produce to great corporations, need may often arise for price regulation by public authority to maintain the public interest.

In deciding upon prices both the farmer and the price commissioner should keep the long-time as well as the immediate effect in mind. It takes decades to build up the dairy industry in a community. Equipments require time for construction. Years are required to build up good herds, and decades are required to train a whole community in the fine art of producing high-class milk. When such a community is diverted from dairying to another line of production, the farmers suffer a great loss while making the change and while adjusting themselves to new lines of production, after which they may again prosper. But if the farmers are needed to produce the supply of milk essential to the welfare of the people of the city, the loss of skilled dairymen will result in a heavy loss to the consumers, who will have to pay higher prices for milk, and probably find it necessary to lower their standards with respect to quality in order to get the necessary supply.

Hence it is the long-time averages which must be considered. The records of one year may indicate that the profits would have been greater had the farmer been in another line of production, similar to that practiced outside of the city milk belt. In contemplating these figures, the farmer should look for the unusual conditions which have made this true. If the conditions are temporary he should hold fast to his present line and recall the years when his profits were much the greater because he was in the dairy business.

If, however, it becomes apparent that permanent changes in market conditions have taken place which account for the change in profits, a move should be initiated to bring about a readjustment of the farming to suit the new market conditions; possibly some dairymen should change to other lines of production. But this is not a matter for hasty action, especially in the case of the dairy industry where public welfare is at stake and where a change has far reaching effects through a series of years.

Changes which the farmer may make in grain production or hog production may be quickly readjusted, but not so with milk production. One's ill-feelings towards other people should not enter his decision. One should not get angry and sell his herd of cows. Cold reason should form the basis of judgment. It is easy to disperse a good dairy herd but it takes years to rebuild it. A much safer plan is to cut down a little on the number of cows by cutting out the least profitable ones and plan to sell some grain or hogs in addition to milk rather than to make a radical change in type of farming.

If the profits of milk production are temporarily low on a large share of the farms in a given city milk belt, due to short crops of grain and hay, which for this reason must be shipped in at heavy cost, the farmer should not only look to the long-time average, and to the maintenance of his market, but he should recognize the occasion of his loss, namely, the short crop, and should lay this loss to the land or to the way he has handled his land and not ask that the consumer should pay the rent on the land which did not produce the feed and also pay for the purchased feed.

The farmer should not be too insistent upon the consumer's price varying exactly with his costs from season to season and from year to year. Custom is a big item in determining what people will eat. So long as prices are the same the customer is not likely to change, but every time the consumers' price changes, consumption customs are shaken; and the more violent the change the more likely the custom is to be upset. It is not only the industry, then, but the market which may be damaged by impassioned actions in times like these.

Just as it is by comparing profits that the farmer makes choice of types of farming, so it is by comparing prices in the market that the consumer makes choice. If it is done in the right way, the price of one commodity may be raised as rapidly as that of its substitute. So long as relative prices are the same the choices may be expected to be the same. If, however, much publicity of an antagonistic sort accompanies the change in the price of one article while the change in another is accompanied by shrewd advertising which wins the sympathy of the consumer, there may be a falling off in the demand of the former and an increase in the consumption of the latter.

In connection with the Chicago milk hearings the idea of comparing the profitableness of the different types of dairying was suggested, with especial reference to ratios between milk prices and butter prices, but apparently the commissioners did not see anything they thought usable in the suggestion. So far as has been noted, relative prices to consumers were not considered as a basis of price-fixing.

The farmers took the lead in the first instance, and were set upon having a price based upon specific costs. It was a very natural thing therefore when the commissioners despaired of ascertaining specific costs, for them to turn to a ratio between the price of feeds and the price of milk as a basis of price regulation. This resulted in the acceptance of what has been known as the Pearson formula.

One weakness of the Pearson formula arises out of the fact that the price of milk is the major factor in determining the prices of many of the articles of cow feed. The price of bran, prepared dairy feeds, or clover hay, are determined largely by the price of milk. For example, a high price of milk stimulates milk production, which stimulates the demand for feed, resulting in an increased feed price, which, according to the formula, provides for a still higher milk price. Thus started on its upward course nothing would stop the upward trend of prices excepting the lack of buyers for the milk at the ever rising price. So far as has been learned, the commission has not arranged to take all the milk which is offered at the price. On the other hand, suppose the price ratio is narrow, resulting in a milk price too low for profit. How would this affect the producers? The farmers would lose money and would produce less milk. The demand for dairy feed would fall off, and the price of feeds would fall. This, according to the Pearson formula, would call for a lowering of the price of milk which would further depress milk production and the price of feeds, and in turn the price of milk, even though the demand for milk might justify a higher price. Thus it is that the Pearson formula possesses elements of danger and will in all probability fail to serve the purpose intended.

The commission has yet the problem of price-fixing to solve. It is believed that after the excitement of the present conflict is past the commissioners will turn to a careful study of the amount and character of the milk demanded at various prices and the character and amount of milk which can be secured at these prices, and will adjust the milk price on the basis of maintaining an equilibrium between demand and supply through a long period. In doing this they will need to take into account the substitutes to which the consumer may turn, as well as profits in other types of farming to which the milk producer may later change if the milk price is fixed too low compared with other prices.

The much talked of law of supply and demand is too little understood. It does not always work perfectly. It might be made to work much better under the guidance of a commission than when left to the free and unequal bargaining power of great distributing corporations on the one hand and the isolated producers on the other.

A properly constituted, permanent price commission might inaugurate an educational program which would improve the mutual attitude of mind of the producer and consumer toward each other, which would make each more considerate of the rights of the other that are in the long run fundamental to the interests of all concerned.

Furthermore, such a commission, well informed with regard to the facts of production, distribution, and consumption, would form a desirable medium for collective bargaining between the organized producers on the one hand and the organized distributors on the other, which appears to be the logical outcome of present tendencies and which would appear to be desirable wherever large numbers of isolated farmers are selling to large corporations such as the milk distributors in the large cities, the packers and the grain dealers, and possibly in many other instances. Even where the more specific functions of price-fixing are unnecessary, there is an important work for price commissioners in studying market conditions and the conditions of supply and in educating both producer and consumer to rational action.

In passing judgment upon the merits of commission prices in comparison with unregulated prices too much weight should not be given to the results of commissions which of necessity have been organized hastily under the stress of war time conditions. It will take time to develop good price commissions; but what is so much worth while is worth striving for.

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Bulletin 293 May, 1918

Wisconsin's Hemp Industry

A. H. Wright

HEMP IN THE SHOCK

Hemp raising in Wisconsin has increased seven-fold since 1912. In certain localities it is a profitable new crop.

AGRICULTURAL EXPERIMENT STATION
OF THE UNIVERSITY OF WISCONSIN

MADISON

DIGEST

Hemp has been grown in Wisconsin for ten years. It has been found that hemp can be grown very successfully in the state, that the climate and certain soils of Wisconsin are particularly suited to the crop, and that the development of labor saving machinery has made the hemp industry one of far reaching importance. Pages 3 to 6.

Several hundred acres must be grown in a vicinity to make hemp production profitable. Cooperative growing is necessary. The state hemp association is stabilizing the industry in the state. Pages 6 to 9.

Wisconsin is the second largest hemp producing state in the Union. The principal centers of production are Fond du Lac, Green Lake, Dodge, and Racine Counties. Pages 9 to 13.

Hemp fiber is a national necessity. In addition to its important use for wrapping cords of all kinds, it is now being used for such vital purposes as thread for sewing army shoes and harness, as caulking in battle ships, and for binder twine. Pages 13 to 15.

Hemp should be grown on fertile soil. Poor soils are not suitable. Hemp is not hard on land, for it removes less plant food than many other farm crops. It improves the physical condition of the soil and is a successful crop for smothering quack grass and Canada thistles. Pages 15 to 20.

Fiber hemp does not mature seed in Wisconsin; consequently, seed for planting is principally obtained from Kentucky. The seed weighs 44 pounds to the bushel and 40 pounds are required to plant an acre. Pages 20 to 24.

Hemp is drilled in a well-prepared seed bed, in the spring, and requires no further attention until it is ready to harvest in September.

Hemp is harvested with a special harvesting machine which spreads the stalks in a thin windrow. After remaining in the windrow several weeks, the stalks are tied into bundles, shocked, and stacked. Pages 24 to 32.

The dry, cured hemp stalks are hauled to a breaking mill. Here the fiber is removed from the woody portion of the stalks. To perform this separation of the fiber, especially constructed and equipped hemp mills are necessary. Wisconsin now has nine of these mills. Pages 32 to 38.

Large yields of hemp fiber are obtained in Wisconsin, averaging 1,200 pounds an acre. The cost of producing the crop is from $8 to $11 more an acre than for small grain crops. The gross returns average $75 an acre. With the advent of modern machinery, hemp can be produced just as easily as corn. Hand labor is no longer necessary and as a result, the hemp industry in Wisconsin is firmly established. Pages 38 to 46.

Wisconsin's Hemp Industry

Of the 42,000 acres of hemp grown in the United States in 1917, Wisconsin grew 7,000. Among the several states growing hemp, Wisconsin ranks second in acreage and production of fiber.

Large areas in Wisconsin are admirably suited to hemp culture, and a firmly established dairy industry helps to insure the continued productiveness of the soil.

The climate of Wisconsin is particularly suited to the production of dewretted fiber of good strength and high quality. The fall months are cool and moist, which makes it possible to ret the crop without scorching or over-retting, an item of vital importance in the production of good fiber.

The yields of fiber obtained in this state have been entirely satisfactory, ranging from 1,000 to over 1,500 pounds to the acre; the quality of Wisconsin's hemp fiber is equal to that produced in any other state; and our farmers have received profitable returns from the culture of the crop.

In the improvement of machinery for handling the crop one of the most serious problems of the industry is being solved. Hand labor is now unnecessary in handling Wisconsin's hemp crop. It is harvested by special machinery, and especially constructed and equipped mills are established in the state for separating the fiber from the stalks. In fact, Wisconsin now has over 70 per cent of the total number of hemp mills in the United States.

Hemp has been demonstrated to be the best smother crop for assisting in the eradication of quack grass and Canada thistles.

Characteristics of the Hemp Plant

Hemp is a woody, tall-growing, annual plant. It may grow from 5 to 15 feet high, but in Wisconsin the average height is from 6 to 9 feet, although it sometimes reaches a height of over 10 feet. Hemp, of course, is grown for the fiber that is in its stems, and in order that the stems may be long and slender the crop is seeded thickly like a small grain crop. As a result of such thick seeding, the plants send out practically no branches, and all but the top leaves drop early.

In hemp, as in animals, the sexes are separate. The flowers of the male plants produce only pollen, and after the pollen is shed they wither and die; the female plants produce the seed, which is fertilized by the pollen of the male, and remain green and continue to set seed until killed by the frost. The male plants generally mature from ten days to several weeks earlier than the female plants. As a usual thing the male and female plants are about equal in number.

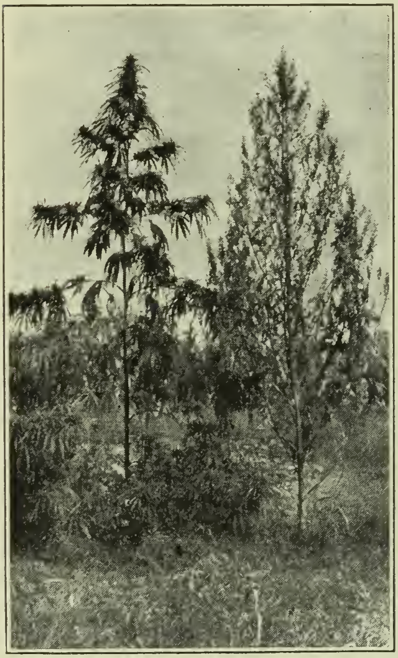

FIG. 1.—MALE AND FEMALE HEMP PLANTS

Hemp is the only field crop in which the sexes are separate. The pollen is produced by the male plants and the seed formed by the female plants. (Office of Fiber Investigations, U. S. D. A.)

The fiber from hemp, known technically as a bast fiber, is obtained from the inner bark of the stem. It is a highly valuable product on account of its great length, strength, pliability, and resistance to water and general wear.

To remove the fiber from the central woody portion of the plants, it is necessary to thoroughly crush the stalks when they are dry. This process is known as "breaking," and the woody portion, when separated from the fiber, is termed "hurds."

THE BEGINNINGS OF WISCONSIN'S HEMP INDUSTRY

In 1908 six acres were grown on the asylum farm at Mendota and three acres on the prison farm at Waupun by the Agronomy department of the Wisconsin Experiment Station in cooperation with the Office of Fiber Investigations of the United States Department of Agriculture. The results were so promising that the investigational work was rapidly increased during 1909, 1910, and 1911. During these years fields were grown at Mendota, Waupun, and Viroqua. At each of these points good results were obtained. At Waupun in 1911 the hemp was grown on land badly infested with quack grass, and in spite of an unfavorable season a yield of 2,100 pounds of fiber to the acre was obtained, and the quack grass was practically destroyed. The results were so encouraging that several neighboring farmers became interested, and in 1912 grew a total of 125 acres. Since that time hemp has been grown in that vicinity every year as a commercial crop. During the last few years, the industry has extended chiefly from Waupun to Brandon and westward through the region between Fairwater and Markesan.

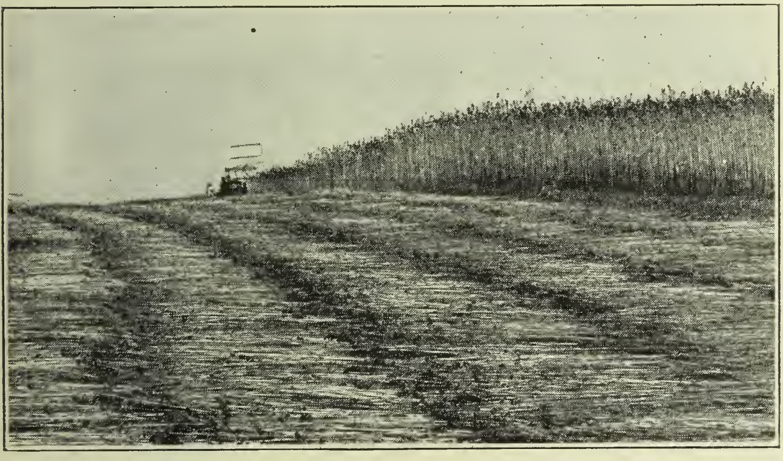

FIG. 2.—HEMP FIELD AT HARVEST TIME

When seeded thickly for fiber the hemp plants grow tall and slender.

To prove that hemp could be grown in Wisconsin was an important undertaking, but the great problem was to obtain power machinery in order that hand methods could be eliminated. When the work with hemp was begun in Wisconsin, there were no satisfactory machines for harvesting, spreading, binding, or breaking. All of these processes were performed by hand. Due to such methods, the hemp industry in the United States had all but disappeared. As it was realized from the very beginning of the work in Wisconsin that no permanent progress could be made so long as it was necessary to depend upon hand labor, immediate attention was given to solving the problem of power machinery. Nearly every kind of hemp machine was studied and tested. The obstacles were great, but through the cooperation of experienced hemp men and one large harvesting machinery company, this problem has been nearly solved. The hemp crop can now be handled entirely by machinery.

Hemp is now on firm footing in Wisconsin; the big obstacles have been overcome, but the final success of the new industry depends upon the kind of judgment used in its further development.

WISCONSIN HEMP AS A WAR CROP

The production of hemp fiber is an item of vital importance in carrying on the work towards winning the war. Wisconsin is at the present time the most promising state for the further development of this industry.

Wisconsin hemp is now used in sewing the shoes worn by American soldiers and hemp fiber is at the present time the only suitable fiber available in sufficient quantities for this purpose. It is also used as cordage in ship building, and hemp tow is the best available material for calking vessels. During the coming year hemp will be used in the manufacture of binder twine and to eke out the scant supply of jute for covering cotton bales.

L. H. DEWEY,
Fiber Investigations,
United States Department of Agriculture.

COOPERATION NECESSARY IN HEMP GROWING

Community interest is essential to the successful production of hemp. One farmer in a community, without the cooperation of his neighbors, will fail if he attempts to grow hemp. Machinery for handling the crop is expensive, and without machinery little or nothing can be accomplished. In this state central breaking mills are necessary. These mills cost from $10,000 to more than $50,000, depending upon the capacity and equipment. Of course a sufficient acreage must be grown in a community to justify the erection of such a mill. The first year there should be at least 300 acres with reasonable assurance of from 500 to 750 acres in successive years. This means that the production of hemp must be concentrated in definite centers, to give assurance of sufficient raw material to make the operation of mills profitable.

ESTABLISHING NEW HEMP CENTERS

There is need of much preliminary work before a new hemp center can be established. The success generally reported with hemp in Wisconsin has excited state-wide interest in the crop, and as a result there is danger of attempting to grow the crop in localities and under conditions where failure is certain.

Not all soils in Wisconsin will produce a profitable crop of hemp; very fertile soils are required. Not only should there be fertile soil, but there should be a sufficient area of such soil to insure about 700 acres of hemp each year for an indefinite time. In Wisconsin hemp should not be grown for two or more years in succession on the same land; consequently, there must be sufficient good soil to provide room for necessary rotations. If there is any doubt about the suitability of the soil, preliminary tests should be conducted the first year. To do this small plots should be grown on several farms in the community and the results carefully observed.

Since a hemp mill is essential to the establishment of a hemp center, a satisfactory site for such a mill is very important. Locating a mill in the country several miles from a railway station is not to be recommended. When so located, transportation becomes an expensive item and the labor problem is made very serious. About 20 men are required to operate a hemp mill and it is difficult to obtain men who will work in the country and even more difficult to retain them.

The ideal location for a hemp center is a small town with fair railroad facilities, surrounded by fertile land. A large town is not so desirable a location as a small one, for too much land is occupied by the town, and the farm land is necessarily far removed from the mill. Then, too, the farmers living near large towns are not, as a rule, easily interested in a new industry and have relatively little community interest.

The community, as a whole, must become interested in growing hemp in order to insure success. To arouse such interest, the subject of hemp should be thoroughly discussed and as much information obtained about the crop as possible. If much interest is shown, public meetings may be held at which the growing and handling of hemp may be explained by someone who understands the subject. If, after careful consideration, a considerable number in the community desire to undertake hemp growing, an estimate should be made of the acreage that could be obtained. If at least 300 acres are promised, an effort should then be made to obtain a hemp mill.

A central mill for breaking the stalks and cleaning the fiber is the only satisfactory plan. Wherever such mills have been established, permanent progress has been made, and where hemp has been grown under other arrangements for handling the stalks, dissatisfaction has often resulted. The erection and equipment of the mill may be financed by outside capital, by a local company, or cooperatively by the farmers of the community. The important thing is that complete arrangements should be made for the establishment of the mill before any acreage is planted.

It is by such methods that new hemp centers have been established. Throughout the development of the industry the Experiment Station has stood firm in its belief that in no case should attempts be made to establish new centers of hemp production until the prospective growers have obtained a general knowledge of the essentials of producing the crop, know that their soils are suitable, and have made all necessary arrangements for the establishment of hemp mills. The Experiment Station is in a position to assist in establishing new hemp centers wherever local conditions warrant.

THE WISCONSIN HEMP ORDER

The stable growth which the hemp industry has made in Wisconsin is due considerably to organized effort. At the very beginning of the industry at Waupun, an organization known as the Rock River Hemp Growers' association was formed. This association was considerably responsible for guiding the new industry through the experimental stage. After the crop expanded and became of state-wide importance, a state association was formed. This association is known as the Wisconsin Hemp Order. It was organized at Ripon on October 18, 1917, and is affiliated with the Wisconsin Agricultural Experiment Association. The object of the Hemp Order is to promote the general welfare of the hemp industry in the state. Its membership is composed of hemp growers and hemp mill operators. Anyone in the state interested in the growing and handling of hemp is eligible to membership.

WHERE HEMP IS GROWN

In Wisconsin hemp is grown chiefly on the dark prairie loams and, to some extent, on the gray silt loams of the timbered sections. The leading hemp producing counties are now Fond du Lac, Green Lake, Dodge, and Racine. The principal towns around which hemp is now grown are Waupun, Brandon, Fairwater, Markesan, Iron Ridge, Union Grove, Picketts, and Milton. Small acreages were grown in 1917 at Waterloo, Brownsville, Randolph, Rosendale, Fond du Lac, Oak Center, Oak Grove, and Baldwin.

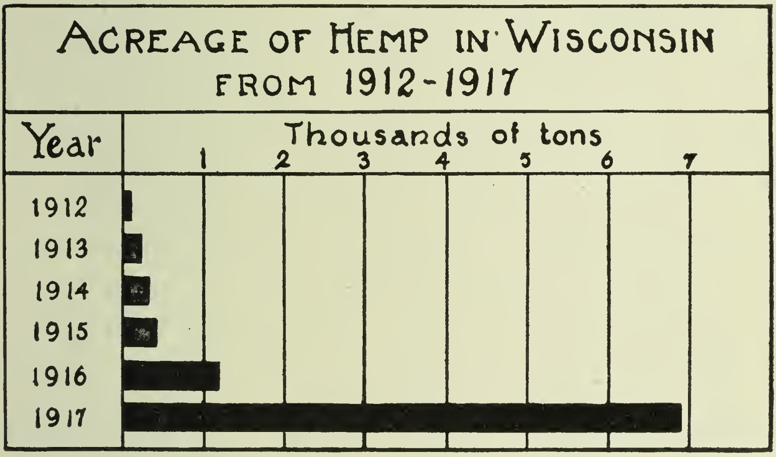

FIG. 3.—THE ACREAGE OF HEMP IN WISCONSIN

The most extensive areas of hemp in Wisconsin are on the rich prairie soils of Fond du Lac, Green Lake, and Dodge counties. The past two years have seen a heavy increase in hemp growing.

In the United States, previous to the Civil War, the chief centers of hemp production were Kentucky, Missouri, and Illinois. From the close of the Civil War until 1912, nearly all the hemp in the United States was grown in Kentucky. At the present time (1918), hemp is grown for fiber in Kentucky, Wisconsin, California, North Dakota, Indiana, Ohio, Minnesota, South Dakota, Michigan, Kansas, Iowa, and Illinois. Of these states the most important are Kentucky, Wisconsin, and California.

Hemp is a native of China, but has been widely distributed into nearly all temperate and semitemperate countries. It is now grown in Russia, China, Japan, Hungary, France, Chile, Turkey, India, Arabia, Africa, Canada, and the United States. Of these the principal countries producing hemp fiber are Russia, Italy, Japan, China, and the United States.

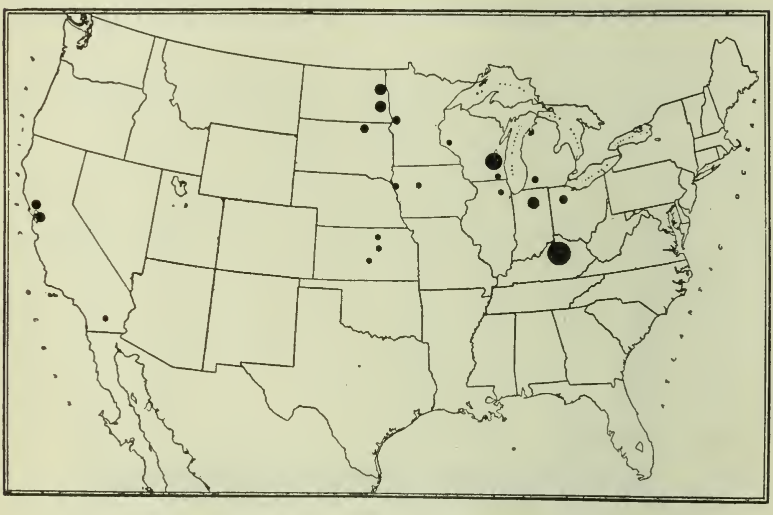

FIG. 4.—WHERE HEMP IS GROWN IN THE UNITED STATES

Wisconsin ranks next to Kentucky in the production of hemp.

Russia, before the war, produced many hundreds of tons of hemp fiber and was the source from which America obtained a large percentage of her imported supply.

Italy has been a very important source of hemp fiber for American mills, but since the war both the Russian and Italian supplies have been greatly reduced.

Japan produces a considerable quantity of hemp fiber, but very little for export as rough fiber. Several varieties of hemp grown in Japan are very satisfactory for fiber production in the United States, according to trials made by the United States Department of Agriculture, but representatives of the Wisconsin Experiment Station have found that they will not mature seed in this climate.

In China hemp is grown both for birdseed and for fiber, but the fiber produced is nearly all consumed by the Chinese people, and consequently very little is exported. The leading varieties of American hemp, such as the so-called Kentucky hemp, had their origin in China. Birdseed types of hemp are grown in Manchuria and Chosen, consequently seed from those countries should not be obtained for planting in this country.

ACREAGE AND PRODUCTION OF HEMP

Accurate data on the world's acreage and production of hemp cannot be obtained, but fairly accurate figures on the acreage, production, and consumption of raw hemp fiber in the United States are available.

TABLE I.—IMPORTS, PRODUCTION, AND CONSUMPTION OF HEMP IN THE UNITED STATES 1876—1917, IN TONS

Averages by years	Imports	Production	Total used
1876–1880	459	7,396	7,855
1881–1885	5,393	5,421	10,814
1886–1890	10,427	8,270	18,697
1891–1895	4,962	5,631	10,593
1896–1900	4,985	5,177	10,162
1901–1905	4,577	6,175	10,752
1906–1910	6,375	5,150	11,525
1911–1913	5,982	5,100	11,082
1914	8,822	1,000	9,882
1915	5,310	4,200	9,510
1916	6,506	9,390	15,896
1917	6,000	20,600	26,600

It is evident that the amount of hemp produced in the United States previous to 1913 was approximately the same each year, averaging annually about 6,000 tons. In 1914 there was a material reduction, and even though there were several states other than Kentucky in which hemp was grown, the total production was only 1,000 tons. In 1915 and 1916 there was a decided increase, and in 1917, the acreage was larger than in any previous year since the Civil War. Imports, it will be seen, have remained practically the same each year, even during the present war.

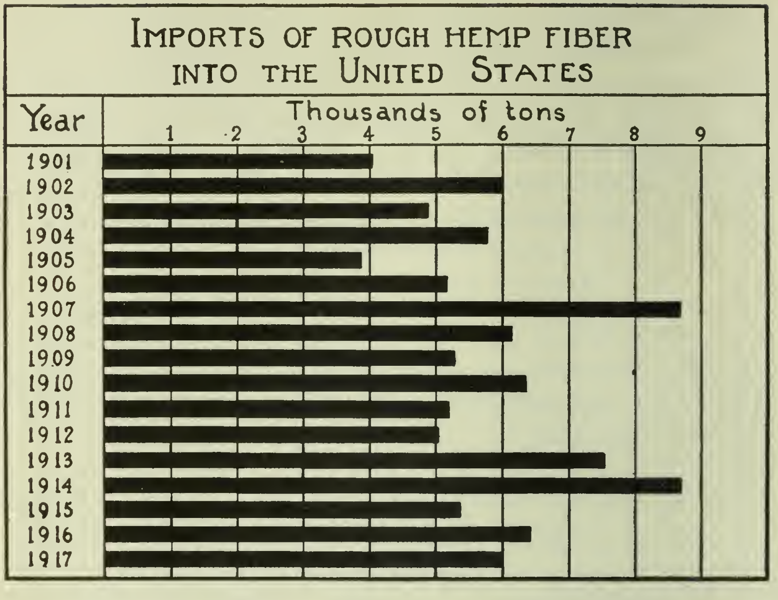

FIG. 5.—IMPORTS OF HEMP FIBER TO THE UNITED STATES

About 6,000 tons have been imported annually—chiefly from Russia and Italy.

The acreage of hemp in the United States has varied from year to year in about the same degree as has the production of fiber. Acreage in different states is shown in Table II.

The 41,000 acres of hemp in the United States in 1917 was an increase of more than 100 per cent over that of 1916, the greatest increase of any year in the history of the American hemp industry.

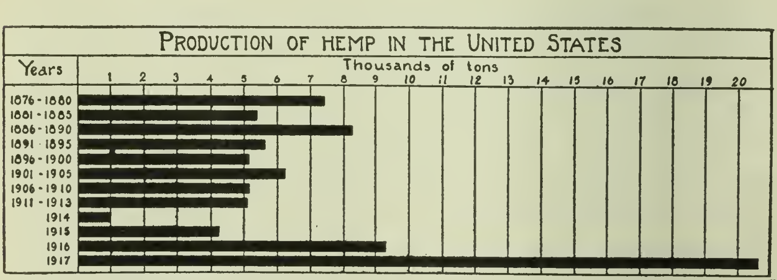

FIG. 6.—HEMP PRODUCTION IN THE UNITED STATES

In 1917 the increase in the hemp acreage was greater than in any previous year of the American hemp industry.

Previous to 1915 the great bulk of the American hemp acreage was in Kentucky, but during 1915, 1916 and 1917 the acreage in other states has been rapidly increasing.

TABLE II.—DISTRIBUTION OF HEMP ACREAGE IN THE UNITED STATES

States	1915	1916	1917
Kentucky	6,500	13,500	18,000
Wisconsin	400	1,200	7,000
California	600	1,600	5,000
North Dakota	....	40	5,000
Indiana	500	800	2,400
Ohio	400	1,000	1,500
Minnesota	....	....	500
South Dakota	....	40	500
Michigan	....	....	400
Kansas	....	....	300
Iowa	....	....	500
Illinois	....	....	100
Total	8,400	18,780	41,200

It is evident that there has been a tremendous increase in acreage during the last three years, especially during 1917. Just how permanent this large increase will be, it is impossible to forecast, but in those states where natural conditions of soil and climate are favorable and where thorough preparations have been made for growing and handling the crop, there is every reason to believe that hemp production is a permanent industry.

USES OF HEMP

Hemp is grown for its seed, for medicine, and for its fiber. In the United States it is important as a fiber crop only.

At present, the principal use of hemp fiber in the United States is in manufacturing ''commercial twines'', or wrapping cords. It is not used to any great extent for manufacturing ropes and binder twine. Minor uses of hemp are for ropes and lines in the navy and as sewing thread for shoes and harness.

The hemp tow is used to a considerable extent as oakum for the caulking of ships, and the packing in pumps, engines, and other machinery.

The present uses of hemp are limited primarily because there has not been enough of the fiber produced in this country to satisfy even the demand for commercial twines, and consequently there was no occasion for adapting machinery for the manufacture of other products from hemp fiber. Previous to the shortage of hemp fiber it was used in the manufacture of a great number of products, including bagging for cotton bales and for numerous other purposes, sacking of all kinds, binder twines, carpets, rugs, seines, nets, fish lines, sewing thread of all kinds, warp for carpets, and for such fabrics as crash toweling, rough sheeting, and rough clothing.

Since Yucatan sisal has become so expensive, a great deal of attention is now being given to experimenting with hemp in manufacturing binder twine. The success of such efforts can not be forecasted, but if it be found that hemp can be used for that purpose hemp production will be stabilized.

The chemical and physical properties of the ultimate fibers of hemp are almost identical with flax. By the simple mechanical process of hackling, now being done by very efficient power-driven machines, hemp fiber is reduced to a condition closely resembling the coarser grades of dewretted flax and may be spun on flax-spinning machinery. It is not quite so fine as flax and can not be used economically to make the finer yarns commonly made of flax fiber, but it is suitable for the coarser yarns and in the present emergency, with available supplies of flax and jute greatly exceeded by the demand, the better grades of hemp may be used more extensively in place of flax, while the cheaper tows should make a very acceptable substitute for jute.

There are certain uses for which hemp is particularly suited and there is no reason why these uses should not be developed. Hemp has great tensile strength and is very resistant to water and to wear. Hence, it is particularly suited for cordage of all kinds, for lines and ropes used in all shipping activities, for canvases used in shipping and wherever great strength and resistance to water are required, for such threads as shoe thread and sacking thread, where strength is more important than fineness, for sewing coarse wearing apparel, for trimmings in millinery, for fastening buttons, for the more strongly and finely woven types of sacking such as grain sacks, sugar sacks, and the like, for the warp of carpets, for the manufacture of service carpets, rugs, hallway rugs, and all forms of floor covering, and for manufacturing the more coarsely woven products such as toweling, curtains, table cloths, and other textiles.

IMPROVING HEMP

Wisconsin is in great need of a variety of good fiber hemp that will mature seed in this climate. With that object in view, the Agronomy Department of the Wisconsin Experiment Station in cooperation with the United States Department of Agriculture began breeding experiments with hemp in 1912. An attempt was made to develop by selection an early maturing strain from Minnesota No. 8. A more uniform fiber type was obtained so far as general characters were concerned, but little or no progress was made in increasing early maturity, although the selection was continued without interruption for five years.

Since 1916 work with selecting and improving hemp has been materially increased. The results thus far obtained indicate that the various strains or varieties from Italy are the most promising for Wisconsin. The Italian variety known as the Ferrara has been grown for two years and many selections made. Enough seed was obtained from the 1917 plots to plant five acres of fiber hemp. This seed was sent out this spring (1918) for a commercial trial. If it produces a satisfactory yield and quality of fiber, the station will rapidly increase the supply of seed of that variety and will intensify the work of selection.

Another strain of hemp obtained from the United States Office of Fiber Investigations has shown much promise. It is the result of a cross between the Ferrara (Italian) and the Minnesota No. 8. By another year enough seed of that variety will be available for distribution over the state for a commercial test.

For the present, Wisconsin must depend upon other states for hempseed, but it is believed possible, from the results thus far obtained, to discover or develop by breeding a desirable strain that will mature seed in this state.

CLIMATE FOR HEMP

Hemp is adapted to the humid sections of the temperate zones, but certain varieties, such as the birdseed forms, grow extensively rather far north in Russia and mature in 60 to 90 days. Hemp for seed requires approximately five months of favorable weather to mature, which necessitates a growing season of 175 days or more. Hemp for fiber will mature in four months, which means that so far as length of season is concerned, hemp for fiber can be grown practically anywhere in the United States.

Hemp is grown to some extent in semitropical regions for oil or drugs, but its natural habitat is in regions of temperate climate, and it is not grown for fiber outside of the temperate zone.

Humid conditions are necessary for the production of hemp fiber. Seed can be matured to some extent in regions of sparse rainfall, but the regions in the United States where hemp has been successfully grown for fiber have a rainfall of 30 inches or more annually.

The climate in Wisconsin is ideal for the production of dew-retted hemp. The falls are cool and fairly moist so that the green hemp can be spread out for retting as soon as it is harvested without any danger of its being scorched or otherwise injured by the sun. As a result, when reasonably well handled, Wisconsin fiber is generally soft and pliable, and possesses considerable ''nature,'' and it has been in great demand among manufacturers.

SOILS BEST FOR HEMP

Soils suited for hemp are best determined by a study of those that have most successfully produced the crop. The section of the United States that has produced hemp most continuously and successfully is that part of central Kentucky generally known as the ''Blue Grass Region.'' While hemp raising in Kentucky is not entirely restricted to the Blue Grass Region proper, yet in the main the hemp areas are underlain with highly phosphatic limestone. The soil, derived from the weathering of the limestone, is a brown loam, varying in color from yellowish to reddish and very high in phosphorus. The chief source of organic matter has been and still is the roots and leaves accumulating from continuous growth of blue grass.

Every successful hemp grower in Kentucky recognizes the great importance of preceding hemp with blue grass for several years. The general practice is to seed to blue grass and use for pasture for a rather long period, ranging from three to ten years or more. This blue grass sod is then plowed in the fall, previous to planting hemp, and is devoted to hemp continuously for three or more years. In this way the organic matter so essential to profitable hemp production is obtained. The soils of the Kentucky hemp region are naturally very fertile in available plant food; so fertile, in fact, that the application of mineral fertilizers gives little or no increased production in any farm crop. It is because of this great amount of fertility that they are so well adapted to hemp production.

Among the states successful in hemp production before the Civil War, Missouri ranked second to Kentucky. The chief soil types upon which hemp was grown in Missouri were the Knox silt loam and the Marshall silt loam. The Marshall silt loam is a prairie soil, high in organic matter, much like the Wisconsin prairie soils. Both of these types are very fertile and easily worked, and originally high in calcium.

In Ohio, Indiana, and Michigan the hemp acreages are practically limited to muck soils. These soils are well decomposed, well drained, and fairly deep. They are generally underlain with clay and gravel. Hemp can be grown on the better forms of muck and other marsh soils, but light, raw peat and any marsh soils poorly drained or underlain with sand are not suitable for hemp.

In California hemp is chiefly grown near Stockton, on delta lands. These soils are alluvial formations of great depths, very fertile and well drained.

In Wisconsin the extension of the hemp industry has been largely on the Carrington loams, particularly the Carrington silt loam. This very fertile prairie soil is of limestone origin and particularly high in organic matter. The Clyde, or marsh border soils, are even better than the Carrington, when properly drained, as they are very rich in organic matter. The Miami soils are naturally deficient in organic matter, and as a result are not as well suited to hemp as are the Carrington and Clyde, but where ample applications of manure have been used, the Miami soils have produced splendid yields of hemp.

No tests have been conducted on the Knox soils of Wisconsin but there is every reason to believe that they are well suited to the crop. On such soils, in most sections, erosion would be an important problem in growing hemp. Manure would also be essential.

It is evident, then, that it is useless to attempt hemp growing on soils lacking in fertility. As a general rule, soil that will produce a good crop of corn will produce a good yield of hemp.

Fertile silt and clay loams which have been abundantly supplied with manure are the best for hemp; heavy clay flats, clay hills and outcrops, sandy and gravelly soils, raw or shallow peat underlain with sand, and all poorly drained soils are entirely unsuited. Marsh soils will give fairly good yields, provided they are well decomposed, well drained, and underlain with clay. At present it appears best to avoid marsh soils and plant hemp only on the better classes of silt loams. The soil that has been given an ample application of manure within the last two years is in the best condition for hemp. The importance of manure for a successful crop can not be overestimated.

Soils for hemp must be rich in fertility, full of organic matter liberally supplied with manure, and thoroughly drained. Never plant hemp on soils that have been run down by poor farming, soils that have been in timothy sod for several years, soils that are low and wet, or soils improperly prepared.

While hemp will not increase soil fertility, there is no question but that it will remove less plant food than many other annual crops and that it leaves the soil in a good, workable condition. Although hemp requires a fertile soil for its profitable growth, it is not "hard on the land."

That hemp may produce a good fiber it is necessary for it to make a rapid growth and to attain a height of six to ten feet in 100 to 130 days. To insure such growth plenty of readily available food materials must be present, but most of these materials are returned to the soil. In hemp 40 per cent of the fertilizing materials removed from the soil are in the leaves and roots and practically all of this is returned. Of the 60 per cent in the stalks, the greater proportion is returned while the hemp stalks are in the swath.

Hemp improves the physical condition of the soil. Its long tap roots penetrate to considerable depths and loosen the under soil layers, and the dense growth of leaves also shades the soil throughout the greater portion of the growing season and prevents baking and crusting of the soil surface. Every grower of hemp fiber says that hemp leaves the soil in such condition that succeeding crops make better yields.

GROW HEMP IN ROTATION

To assist in maintaining fertility of the soil, hemp should be grown in rotation with other crops. In deciding on the place hemp should occupy in the rotation, it is important to remember that hemp requires an abundant supply of evenly distributed organic matter; that an even growth of the hemp stalks, both in height and in diameter, is very important; that soils with an irregular distribution of fertility should be avoided.

In Wisconsin, the most satisfactory place for hemp in the rotation is after corn. The corn should have been preceded with clover sod, well manured, and plowed in the fall. Hemp will also follow to good advantage potatoes, cabbage, or any other cultivated crop. Where it is impracticable to precede hemp with a cultivated crop, it may be seeded on clover sod which was evenly manured and plowed in the fall. The chief objection to planting hemp after clover is that the fertility is likely to be irregular, especially when coarse manure has been applied to the clover. This irregularity in the fertility will produce an uneven growth of hemp, which is very undesirable. Good results have been obtained, however, by following clover with hemp, when proper precautions were taken in spreading manure evenly and in plowing and thoroughly working the soil.

Hemp should not follow timothy meadow, blue grass sod, nor pasture in Wisconsin. Neither should hemp follow any small-grain crop, unless the soil is very well supplied with manure.

Hemp will leave the soil in splendid physical condition for any spring sown small grain. It also leaves the land relatively free from all kinds of weeds and consequently it is a good crop to precede sugar beets or canning peas, for these crops especially require a clean seed bed.

The following rotations have been found applicable to Wisconsin conditions:

FOUR-YEAR ROTATION

Small spring grain crop (seeded down to clover)
Clover for hay and pasture (manured and fall plowed)
Corn, potatoes, or similar crops
Hemp (then back to small grain and clover)

In this rotation many growers include timothy with the clover. There is no objection to this if the land is not left to sod more than one year.

THREE YEAR ROTATION

Small-grain crop (seeded to clover)
Clover (manured and fall plowed)
Hemp (then back to small grain and clover)

In this rotation considerable attention should be given to using well-pulverized manure and to spreading it evenly. The clover sod should be worked thoroughly in the spring to insure a compact, smooth seed bed.

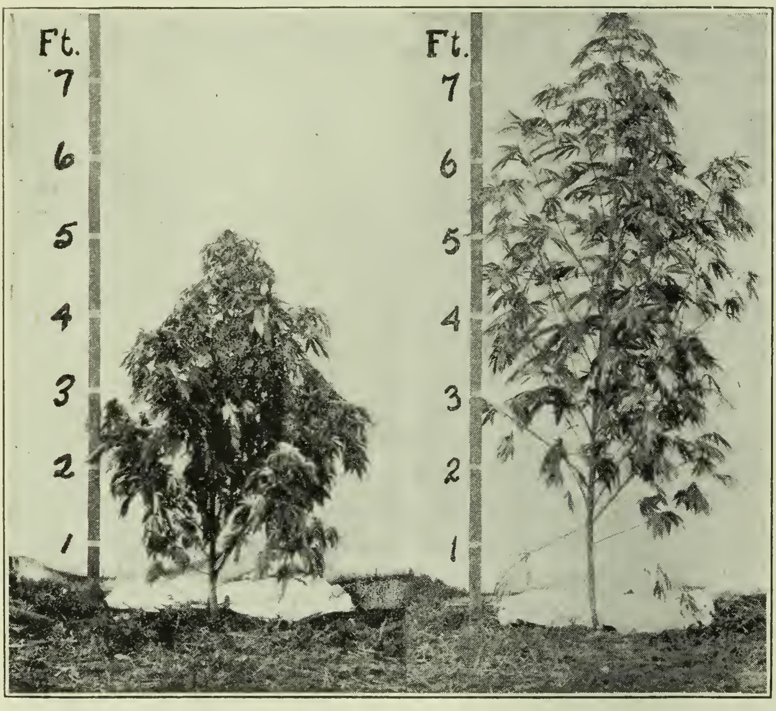

FIG. 7.—GROW ONLY THE FIBER VARIETIES IN WISCONSIN

The tall and open branched type is grown for fiber. The short densely branched bird-seed type should be avoided.

VARIETIES OF HEMP

Hemp that is suitable for fiber does not mature seed in Wisconsin; consequently no Wisconsin varieties have been established. A great deal of attention is being given by the Experiment Station to the development of a variety that will mature seed in this state and some progress has been made. The hemp that has been grown so far comes from Kentucky seed.

There are three fairly distinct types of hemp: that grown for fiber, that for birdseed and oil, and that for drugs. The fiber type is comparatively tall and slender, sparsely branched, with long internodes and distinctly hollow stems. The birdseed type is short, greatly branched, with short internodes, and nearly solid stems. The drug type is similar to the birdseed type, but the leaves of the female plants are more waxy or resinous, the foliage more dense, and the stems more nearly solid. Both the birdseed type and the drug type are unsuited for fiber production and should not be grown in Wisconsin.

The varieties of fiber hemp grown in the United States are known largely by the name of the country or place from which the seed was originally obtained. As a result we have such names as Chinese hemp, Japanese hemp, Russian hemp and American or Kentucky hemp. More specific names have been given to varieties tested and developed in the United States. The more important of these are Minnesota No. 8, Keijo, Malanyu, Hankow—all of Chinese origin; Ferrara or Bologna, Carmagnola, Itamington, Carymington, Ferramington—all of Italian origin; Tochigi and Hiroschima—both of Japanese origin.

From tests made of hemp from practically every country* it is evident that the best fiber producing kinds are from China, Japan, Hungary, and Italy. It should be remembered, however, that not all hemp in those countries produces good fiber, for there are undesirable varieties grown in each of those countries. Since the desirable fiber varieties, from China, Japan, and Hungary, require from 150 to 160 days of favorable weather to mature seed they will not produce seed in commercial quantities in Wisconsin. Of the early-maturing varieties, those from Italy are the only promising ones. They will mature seed in Wisconsin in from 130 to 140 days, being fully 20 days earlier than the late-maturing varieties. Generally, hemp from Russia, India, France, Chile, Turkey, Arabia, and Africa is not desirable for fiber production.

Until a more satisfactory type or variety of hemp is obtained, the Wisconsin growers should use the Chinese type, commonly known as Kentucky or Minnesota No. 8. As a rule, foreign importations should be strictly avoided. Occasional lots from foreign countries might be very satisfactory, but the chances of getting the wrong type are very great. No one can tell by examining hempseed to what type or variety it belongs.

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*Tests made by the U. S. Office of Fiber Investigations.

WISCONSIN USES KENTUCKY SEED

Since the Civil War the production of hempseed has been almost entirely limited to the bottoms of the Kentucky River and its tributaries. In Kentucky some upland hempseed is produced each year, but its production is generally unprofitable and the amount grown of little consequence. In 1917 several thousand bushels of seed were produced outside of Kentucky, principally in California, Ohio, and Kansas. While hemp for fiber is a successful crop in the extreme northern states and in southern Canada, hempseed seemingly must be produced in sections farther south.

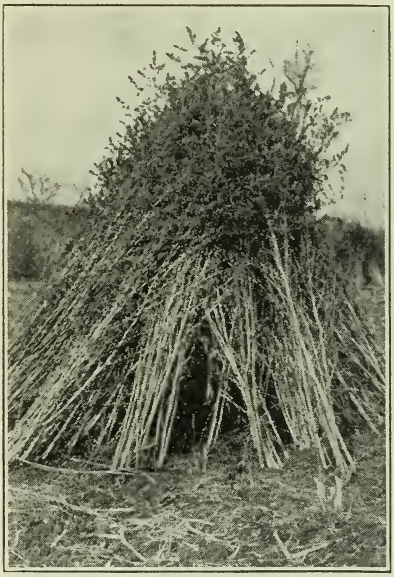

FIG. 8.—A SHOCK OF SEED HEMP

Hemp when grown for seed is harvested by hand and placed in shocks similar to corn. (Office of Fiber Investigations, U. S. D. A.)

That Wisconsin farmers must depend upon Kentucky River bottom growers to produce seed is most unfortunate, and before a dependable supply of seed can be obtained it will be necessary to have it produced elsewhere, unless there is a radical change in the manner of handling and selling seed in Kentucky.

During the last few years the price of hempseed has been unstable. This condition of the market has not been due to a lack of seed to supply the demand, for each year several thousand bushels of seed have been held over, but it has been largely due to a complete lack of organization and to the activity of seed speculators. The price that the grower of fiber has been compelled to pay for seed has often been unreasonable, and such prices, together with the very unstable condition of the market, are seriously injuring the hemp industry, not only in Wisconsin but throughout the whole United States. The future safety and permanency of the industry in Wisconsin demands that a new and dependable source of seed be obtained. The Experiment Station in cooperation with the United States Office of Fiber Investigations has investigated prospective sections for establishing new centers of hempseed production and such work will be vigorously promoted.

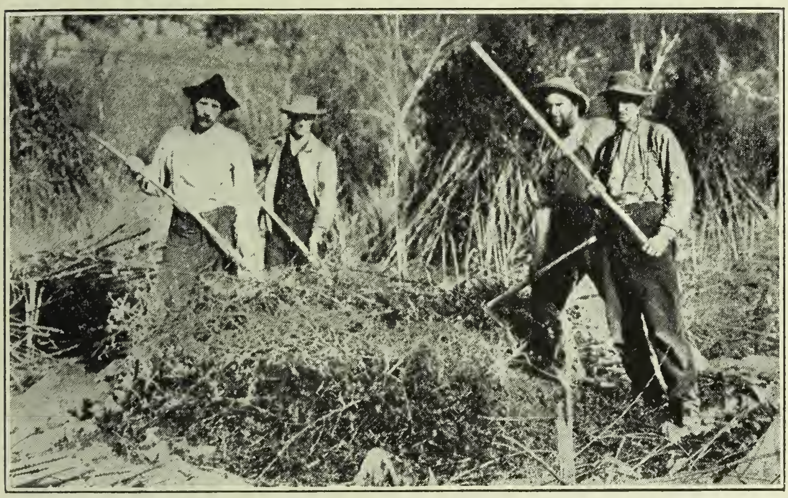

FIG. 9.—THRESHING HEMP SEED

In Kentucky, where practically all American hemp seed is produced, threshing is done by beating out the seed by hand. (Office of Fiber Investigations, U. S. D. A.)

HOW HEMP SEED IS GROWN

The growing of hempseed is an entirely different business than the growing of hemp for fiber; under ordinary circumstances the same crop can not be used for both purposes. When grown for fiber, the crop is harvested before the seed is mature. When grown for seed, the hemp is planted in hills or wide rows and cultivated. The plants then form many branches and become so coarse and woody that they are practically useless for fiber.

Hemp for seed is planted in the spring, on fertile soil, in hills four to five feet apart each way. The planting is done by hand, ten to fifteen seeds to the hill, and the seed covered with the foot or with a hoe. Hemp is cultivated the same as corn. When the plants are six to eight inches high, they are thinned down to from four to six plants in a hill. In thinning, the plants are usually pulled by hand. After thinning, cultivation is continued until the plants become too large.

In the latter part of August (in Kentucky) the male plants are removed, for they are of no value after they have shed their pollen, and if allowed to remain they occupy room which is needed for the full development of the female (seed) plants. When the seed is sufficiently ripe, it is cut by hand and shocked.

After the shocks are completely cured, and when the weather is very dry, an entire shock is thrown on a large canvas spread on the ground, and the seed and chaff beaten out with sticks. Seed threshed in such a manner is full of dirt, leaves, and stems, and requires thorough recleaning, for which both hand and power fanning mills are used.

The average yield of hemp seed in Kentucky is estimated at 16 bushels an acre. A bushel of seed weighs 44 pounds.

PROVIDE LEVEL SEED BED

Hemp requires a deep, firm seed bed, with the surface thoroughly pulverized. Particular attention should be given to obtaining a smooth surface so that the crop may be cut low and even. Fiber hemp should be cut very close to the ground, for the higher the stubble the greater the loss of fiber. Failure to provide a level surface means a considerable loss.

In some sections, the soil bakes readily and may seriously interfere with obtaining a good stand of hemp, for the young plants are very tender and are unable to force their way through a heavily crusted surface. This condition cannot be remedied by harrowing just as the plants are coming up. On such soils it is necessary previous to planting hemp to provide organic matter on the surface. This may be accomplished by a top dressing of finely pulverized manure, or by back-setting sod.

In preparing soil for hemp, fall plowing is preferable; otherwise, plow as early in the spring as conditions will permit. The land should be thoroughly worked with the disk or harrow in the spring. A thorough harrowing should be given just before the hemp is seeded to break up any crust that has formed and to destroy weeds which have germinated.

SEED BROADCAST OR DRILL

Hemp is seeded thickly, either broadcast or with a grain drill. In broadcasting the work can be done either by hand or with a broadcast seeder. Drills that plant in rows six inches apart or less are preferred to the eight inch drills. Any common grain drill will do satisfactory work, but the special four inch drills made for grass seeding are very good. There is no advantage in cross drilling; drilling one way provides just as good a stand. Great care should be exercised to avoid too deep planting. The hemp seeds are very small and the young plants are very tender. Plant just deep enough that the seeds may be covered; covering more than one inch in any soil is unsafe.

The amount of seed needed varies from a little less than three pecks to a bushel an acre. In Kentucky three pecks are sufficient. Some growers in Wisconsin have obtained very satisfactory stands from planting only three pecks, but averaging the experience of growers in Wisconsin, 40 pounds an acre is sufficient to insure a good stand. When hemp is planted too thickly, a great many short, small plants result. These plants are collectively called undergrowth. If the hemp is planted too thinly, the plants become coarse and uneven in growth. Generally, it is better to plant a little too thickly and have some undergrowth than to plant too thinly and have coarse, uneven plants.

Hemp for fiber is planted relatively early in the spring, before May 10 in Wisconsin. The usual practice is to plant after the seeding of small grain and before corn planting. Light frosts and freezes do not seriously injure hemp in the spring, and it is preferable to plant early and allow the crop to be subjected to spring frosts and freezes rather than plant late and shorten the time for harvesting and retting in the fall. Where a large acreage is planted by one grower it is a good plan not to seed the hemp all at one time. Instead, part should be planted as early as possible and other portions at intervals of about a week. The hemp will not then mature all at once, and a considerably longer period will be available for harvesting. After the hemp is seeded, nothing remains to be done until it is ready to harvest.

HEMP DESTROYS WEEDS ON FERTILE LAND

On fertile soils, hemp is the best smother crop for all kinds of weeds. Wherever hemp has been grown in America it has left the soil freer from weeds than has any other crop. In Wisconsin hemp has proved to be the most satisfactory smother crop for quack grass and Canada thistles. Early experiments that showed the value of hemp as a smother crop led Wisconsin farmers to grow it on a commercial scale. A large acreage is still seeded to hemp each year on soils infested with quack grass and Canada thistles.

Too many people have the idea that land infested with quack or thistles can be plowed in the spring, harrowed, and seeded to hemp, and that the hemp will entirely destroy these weeds. In very favorable seasons, and under the best conditions, quack and thistles might be overcome by such a method, but experience has shown repeatedly that hemp planted on quack grass or Canada thistle land where no attention has previously been paid to subduing these weeds, will fail both to smother out the weeds and to produce a satisfactory growth of hemp. It is highly important, therefore, that soils that are so infested be prepared properly.

Weed infested lands should be plowed in July or August of the year preceding the planting of hemp. The plowed land should be cultivated with the spring-tooth harrow every week until further growth of the weeds is prevented by the freezing of the soil. If there are many loosened roots, remove them with the hayrake, leave them in windrows, and burn them.

Use heavy applications of well-rotted manure, plowed under in the fall or as a top-dressing in the spring. Early in the spring the soil should be worked into a good seed bed, and if quack and thistles appear, they should be thoroughly subdued with a good sharp disk. If necessary, follow the disk with a spring-tooth harrow. Keep the weeds down to the very time the hemp is seeded. If the spring is cold and wet it is advisable to delay planting until the soil is sufficiently warm to insure immediate germination of the seed. On such weed infested land, seeding can be delayed until the first of June, though ordinarily earlier planting is preferable.

HEMP WILL NOT BECOME A WEED

Though hemp escapes from cultivation and occasionally appears from year to year as a volunteer plant, it does not become a weed. It may continue to grow in fence corners, roadsides, and other waste places, but it seldom, if ever, persists in cultivated fields.

Wisconsin hemp is, as yet, entirely free from attacks by insects and diseases. Not one report of injuries to the crop from insects or plant diseases has been received. The chief enemy to hemp in Kentucky is a parasitic plant known as the "branched broom rape," but this parasite has not appeared in Wisconsin.

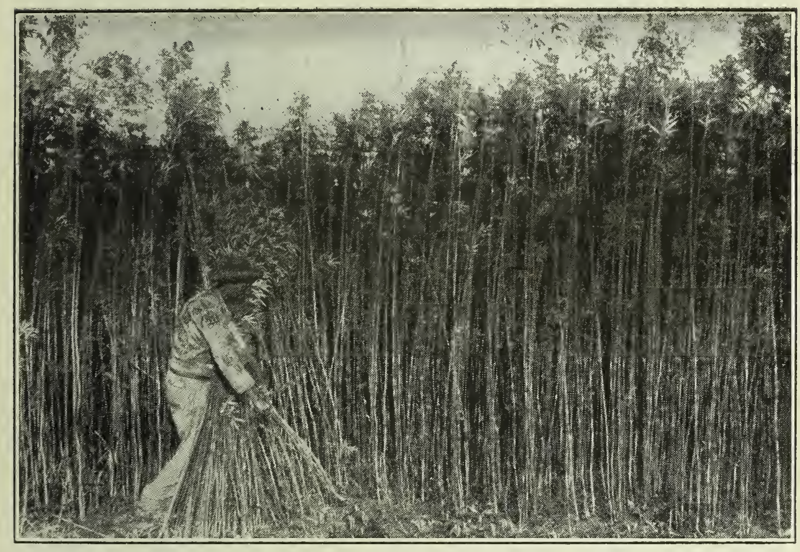

FIG. 10.—HARVESTING HEMP BY THE OLD HAND METHOD

Before modern harvesting machinery was developed, hemp was harvested by a laborious hand process. (Office of Fiber Investigations, U. S. D. A.)

Harvest Crop When Mature

Fiber hemp should not be left until the seeds mature before it is harvested. The proper time to harvest is when the pollen of the male plants is practically all shed, or not earlier than the time at which the male plants are in full bloom and pollen is being shed. If hemp is harvested too early, the fiber is immature and consequently, it will be very weak.

Harvesting should not be delayed very long after the plants are sufficiently mature, for injury to the quality of the fiber may result. In northern states where the season is short and there is danger of the crop being covered with snow before it is well retted, prompt harvest is especially important. In Wisconsin, harvesting usually begins about September 10 and should be completed not later than October 1.

HEMP HARVESTER SAVES LABOR

Outside of the United States hemp is still harvested by hand, and until the last few years hand harvesting has been generally practiced in America. Even now much of the Kentucky crop is harvested by negroes with a hand hemp-hook. Several machines have been devised for harvesting the crop, but the first successful machine and the only one considerably used previous to 1917 was the self-rake reaper. This machine does very satisfactory work, but it leaves the stalks in bundles or gavels which must be spread out by hand in thin layers or swaths. In 1917 a machine especially devised for havesting hemp was placed on the market. This machine not only cuts hemp, but spreads it at the same time, leaving the stalks in an even swath. The work is

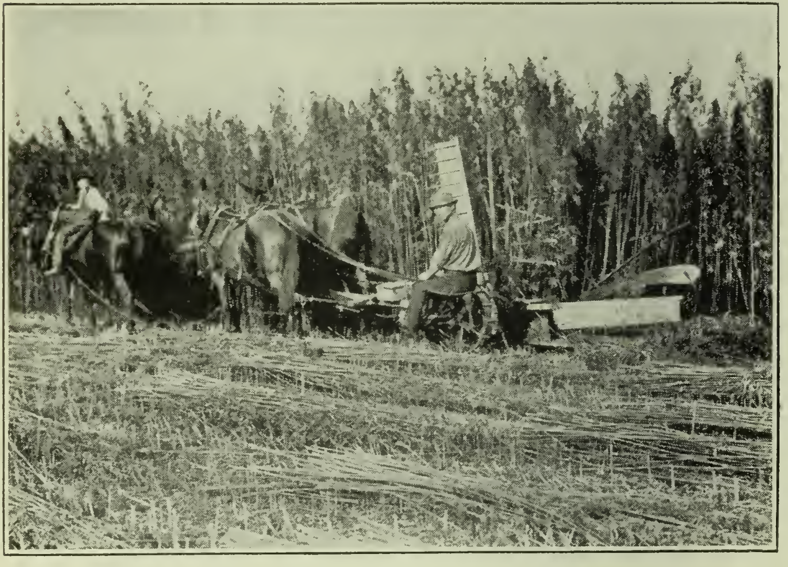

FIG. 11.—HARVESTING WITH THE SELF RAKE REAPER

The self rake reaper was a great improvement on the hand method. In some sections of the country it is still suited to conditions. (Office of Fiber Investigations, U. S. D. A.)

done much better than by hand as the butts are more even and there is less crossing and tangling of the stalks. As an experimental machine it has done exceptionally well, and there is no question but that it will be widely used and will be a great factor in placing the hemp industry on a permanent basis.

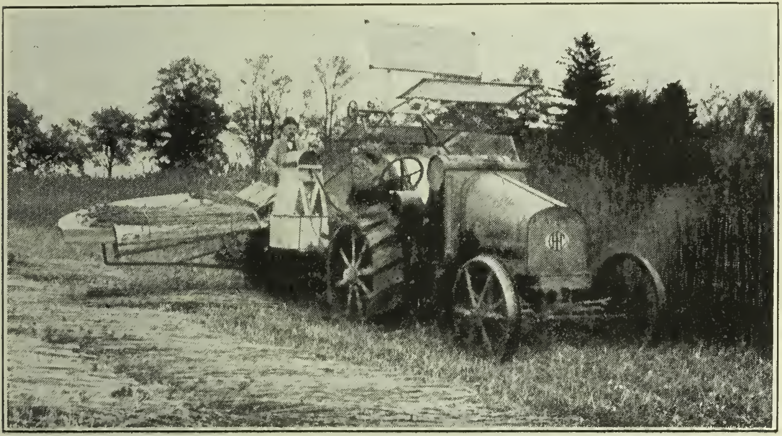

FIG. 12.—THE NEW HEMP HARVESTER AT WORK

The modern hemp harvester, which was used for the first time in 1917, promises to revolutionize the hemp industry.

HEMP IS DEW RETTED

In America, all hemp is dewretted; in southern Europe water-retting is the general practice. Dewretting is accomplished by leaving the hemp stalks spread out on the surface of the ground, where they are exposed to the action of dews, rains, frosts, and sunshine. The object is to allow the stalks to undergo a process of fermentation or partial decomposition, by which the inner bark is loosened from the wood so that the fiber may be easily separated from the "hurds," or woody parts.

In Wisconsin the stalks should be spread as soon as harvested. It requires from four to ten weeks to properly ret hemp in this state. Heavy dews, light rains, sunshine, and moderately warm weather are very desirable. Continuous moist cloudy weather will not give as good a color to the fiber as will intervals of moist weather and sunshine. Weather conditions in Wisconsin are usually about right for dewretting.

Hemp may not ret sufficiently to allow it to be taken up before it is covered with snow. In such cases, it is necessary to leave the hemp until the snow melts. If thaws do not occur during the winter, the hemp will not be damaged, providing it is taken up soon after the snow disappears in the spring. If it is allowed to remain long after the snow is gone, there is great danger of over-retting.

It is important to know when hemp is properly retted. Under-retting or over-retting seriously affects the quality of the fiber and also interferes with separating it from the wood or hurds. Well-retted plants should be dark gray or brown in color, all the green color having disappeared. When a few stalks are taken in the hands and broken by rapidly bending them back and forth, the fiber should readily separate from the wood. To avoid over-retting, the stalks should be examined frequently.

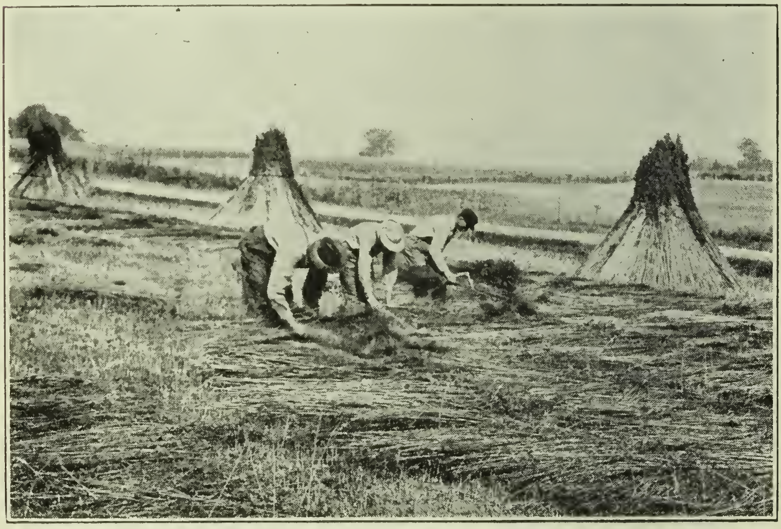

FIG. 13.—GATHERING AND BINDING RETTED HEMP

After the stalks are properly retted, they are picked up, bound in bundles, and shocked. (Office of Fiber Investigations, U. S. D. A.)

RETTED STALKS BOUND IN BUNDLES

After the stalks are properly retted, they are gathered and bound in bundles. These bundles, made a little thicker than corn bundles, vary from 10 to 12 inches in diameter. They are tied either with a hemp stalk or with binder twine, stalks being used when the work is done by hand. The bundles are then butted, by chucking them up and down on the ground several times, and placed in rather loose shocks. The shocks should be securely tied to prevent their being blown over.

Previous to last fall (1917) all hemp was bound by hand. One man can bind from one to two acres a day. Hand binding is not very difficult nor expensive, and if the grower has but a few acres, it will probably pay him to do the work by hand.

A machine, called the gather-binder, was devised last year for gathering the stalks from the swaths and binding them. Although this machine is still in the experimental stage, it promises to do very satisfactory work, and there is every reason to believe that it will become a permanent addition to the hemp industry.

CARE NEEDED IN SHOCKING AND STACKING

The hemp should be shocked soon after binding. The shocks should not be very large, and they should be set up rather loosely so that the air can circulate freely between the bundles and dry them.

Since the central breaking mill has come into prominence in Wisconsin it has been customary to deliver the hemp directly to the mill soon after shocking, where the stalks are broken at once. Some fields are either stacked on the farms where they are grown, or are hauled to the breaking plant and stacked in outside stack yards. It is not a good practice to leave hemp in the shock for very long periods.

Stacking is a practice to be recommended strongly whenever considerable time is to elapse between retting and breaking. When placed in the stack, hemp goes through a so-called sweating process which is beneficial. A more even retting and a more uniform color of fiber is obtained.

Great care should be exercised in building stacks. They should be so constructed that each layer of bundles has a very pronounced pitch. The center should always be kept high. In lapping, but little of the butts of each layer should be exposed to the weather, as the exposed parts become decomposed and the fiber is practically destroyed if left long in the stack. No special type of stack cover has yet been used for hemp.

DRYING HEMP STALKS

Hemp stalks must be perfectly dry before they can be broken satisfactorily. Failure to recognize that fact has been responsible for most of the failure in breaking hemp. The prevailing idea has been that the breaking of hemp should be handled in a manner similar to threshing grain, by portable machines that could be moved from one farm to another, and portable machines have been universally used until the last three years. In seasons of favorable weather such a method works out very well, but in Wisconsin there are usually but a few weeks out of the year during which hemp is sufficiently dry to break to advantage. This method, which was dependent upon the uncertainty of the weather, was very unsatisfactory, and it has been entirely replaced by kiln-drying, one of the most important advances in the development of the hemp industry.

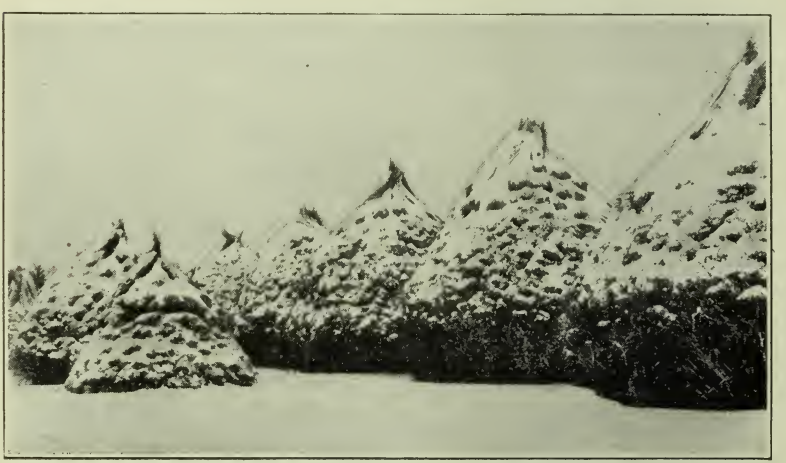

FIG. 14.—A WISCONSIN HEMP STACK YARD

The dry retted stalks are hauled to the breaking mills and stacked before they are "broken out."

Kiln-drying is now considered an essential part of the breaking process. Since kiln-dried stalks are used, breaking is not dependent upon the uncertainties of the weather. Instead, a regular crew of men can be given steady employment and the brake can be operated the year 'round, day and night if necessary. The use of the dry kiln has made of hemp breaking a well-organized, stable business, instead of a troublesome job to be done whenever weather conditions would permit.

BREAKING THE HEMP

When the stalks are properly retted and cured, they are ready for the hemp brake. Breaking is the crushing of the wood underneath the layers of fiber to such an extent that the wood can be readily separated from the fiber. Though hemp has been grown in the United States since colonial times, until the last three years, the crop has universally been broken with hand brakes. Power machines have frequently been devised and discarded, and even at the present time there are no power machines used in Kentucky.

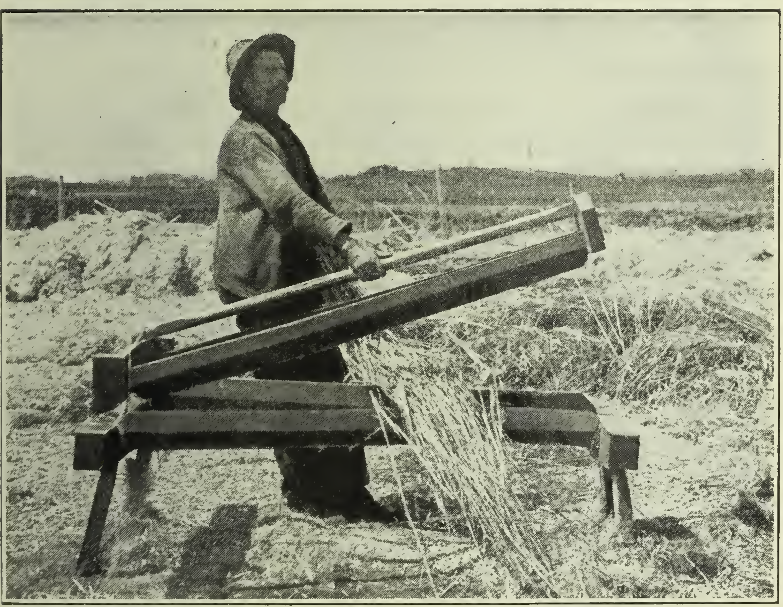

FIG. 15.—THE HAND BRAKE

Before the coming of modern machinery, all hemp was broken by hand—a back-breaking, monotonous job.

Hand Brakes. The hand brake is a very simple device, but its operation demands hard work and much skill. One hundred pounds of cleaned hemp is a good average day's work for one man, although there are records of as high as 400 pounds. Hand brakes must be replaced by power brakes because breaking by hand requires too much time and labor; because the hemp must be over-retted before it can be satisfactorily handled on the hand brake; and because such a method necessitates breaking only when the weather is favorable.

Hand brakes have never been used for handling commercial crops in Wisconsin; power brakes have been used throughout. The success of power brakes is made evident by the fact that Wisconsin fiber is in as great demand as that produced anywhere in the United States.

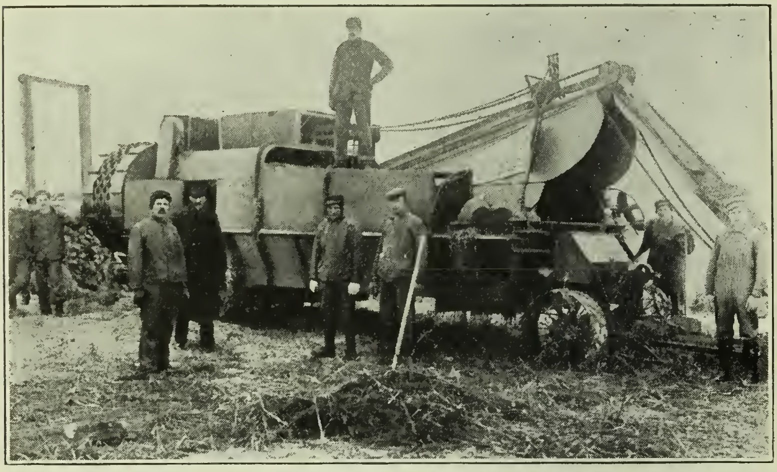

FIG. 16.—FIRST BRAKE SUCCESSFULLY USED IN WISCONSIN

This brake was first used as a portable machine. Breaking in the field was discontinued. It is now housed in a central mill.

Power Brakes. The great problem of breaking hemp in Wisconsin is now practically solved. Power brakes are established and doing very satisfactory work.

The first successful brake tested in this state has been used for several years by the Rock River Hemp Mills at Waupun. It was originally intended as a portable machine, but the idea of moving it from one farm to another has been given up and for the last two years it has been housed in a breaking mill, to which the hemp stalks are hauled.

The majority of the breaking machines now in use in Wisconsin are of the fluted roller type.

Another type of brake is now being tried out near Brandon.

The breaking is done by means of fluted rolls, but instead of the stalks being fed end-wise, as in the case of the other fluted roller machines, they are fed to the rolls at an angle and by means of a specially devised feeding table. This machine has much promise but is still in the experimental stage. Many other types of brakes have been tested in this and other states, but thus far they have not proved to be as satisfactory as the fluted roll brakes.

CENTRAL BREAKING PLANTS BEST

Previous to the last few years, all dewretted hemp has been broken out in the field with portable hand or power brakes. Such a method necessitated little or no hauling. Under the modern plan of central plants which house the breaking machinery, it is necessary to haul the retted and cured stalks over distances varying from less than a mile to several miles. Just how far hemp can be hauled profitably will depend upon the condition of the roads and the price obtained. Generally speaking, two horses will draw from 3,000 to 4,000 pounds of cured stalks, which represents the yield of one-half acre of average hemp. If the roads are reasonably good, hemp can be hauled profitably as far as five to seven miles. In Wisconsin it has sometimes been hauled ten miles.

Hauling is by no means as expensive as it is generally thought to be, and it is certainly better to draw the stalks several miles and deliver them to a central breaking plant than to break them in the field with portable machines and undergo the long delays which invariably result from unfavorable weather.

THE MODERN BREAKING MILL

The great advance made in the production of rough hemp fiber has come largely as a result of the development of the central breaking mill. The several mills now operating in this and other states have been very successful and there is every reason to believe that the principle of breaking hemp in fully equipped plants is correct, and that it marks permanent progress in the development of the hemp industry.

The modern hemp mills, several of which are now established in Wisconsin, consist of a receiving room, dry kilns, breaking room with brakes, scutchers and balers, boiler room, and engine and fan room. The receiving room is not only used for receiving the stalks but is generally used for storing sufficient hemp stalks to insure continuous operation of the mill during periods of unfavorable weather which prevent the delivery of stalks from fields and stack yards.

From the receiving room the stalks are conducted through the dry kilns, where the excess moisture is removed by means of a hot air blast. The thoroughly dried stalks are then fed to the breaking rolls where they are reduced to a crushed mass. This mass of broken stalks passes over a series of shakers by which most of the loose hurds are separated from the fiber, and is then conducted between the scutching wheels for more complete removal of hurds.

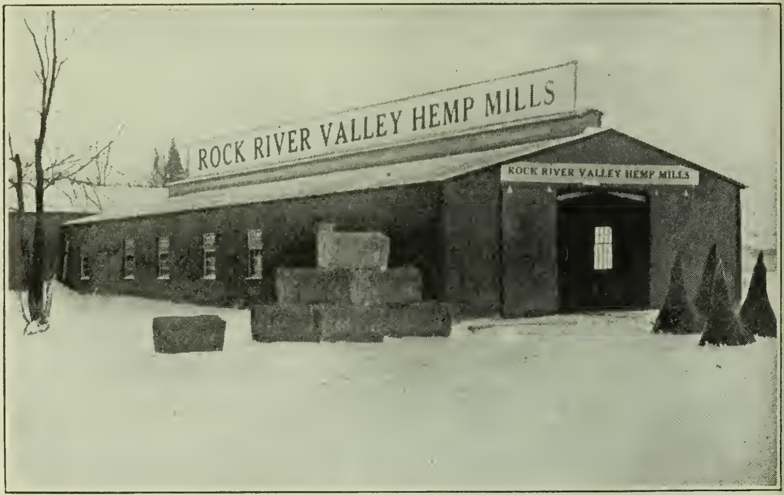

FIG. 17.—CENTRAL BREAKING MILL AT WAUPUN

This mill was constructed by the first hemp company in the state, and is the second mill in the United States. The first mill was built at Brandon, Wisconsin.

The fiber, which is then fairly clean, is twisted into coarse hands and baled. The baled fiber is the final product of the hemp mill and is known commercially as rough fiber. As such it is sold to cordage and spinning mills.

Hemp breaking mills are now in operation in Wisconsin at Waupun, Alto, Brandon, Fairwater (2 mills), Markesan (2 mills), Union Grove, and Iron Ridge. Arrangements have been made for erecting others at Milton, and Picketts.

Outside of Wisconsin there are but seven fully equipped and successfully operating mills. Wisconsin has, therefore, more hemp mills than all the other states combined.

SCUTCHING THE FIBER

After hemp stalks are dried and broken the woody part, called hurds, must be separated from the fiber; this process is called scutching. Before modern power brakes were used, all scutching was done by hand; the stalks were broken and the uncleaned fiber whipped over the brake and shaken until it was free from hurds.

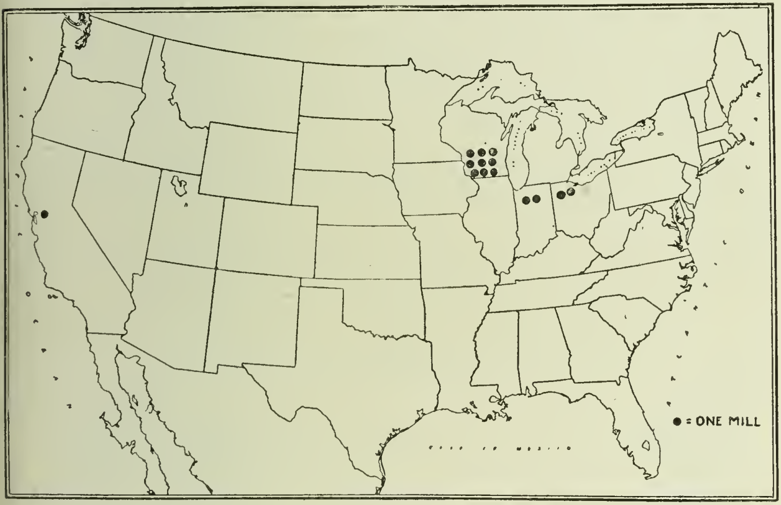

FIG. 18.—NINE HEMP MILLS IN WISCONSIN

This state has nearly twice as many plants for handling hemp fiber as all the other states. Wisconsin has led in the introduction of labor saving devices in the hemp industry. Michigan has receently equipped a mill, and California now has two mills.

In Wisconsin, where machine brakes are used, the cleaning is done with power scutchers. These scutchers consist of from two to four large cylinders, on the outside surface of which there are wooden slats. The cylinders are stationary and revolve toward each other. The uncleaned fiber is conducted between these wheels and held firmly in the center by means of a clamp-conveyor. As the fiber passes between the scutching cylinders the hurds are combed out. A device for off-setting the hemp in the clamp-conveyor is necessary to clean the middle portion of the fiber, and scutchers with such a device are now successfully used.

YIELDS OF HEMP

The yields of hemp in Wisconsin have been good. The average of the state for the last several years has been higher than the average yields of Kentucky and equal to those obtained in any other state except California.

The yields of rough fiber in Wisconsin have usually ranged from 800 to 1,400 pounds to the acre. The average for the state in 1916 was estimated at 1,200 pounds and yields of as high as 2,100 pounds are on record. In 1917 a considerable acreage was planted on unsuitable soil, which reduced the average for the state to 1,100 pounds. Good yields have always been obtained in Wisconsin wherever the crop was planted on fertile and well-prepared soil.

For the sake of comparison the following estimate of acre yields in the leading hemp producing states is given:—

TABLE III.—ESTIMATED YIELDS OF HEMP FIBER IN LEADING HEMP STATES

State	Pounds to the acre
Kentucky	1,000
Wisconsin	1,200
Indiana	1,200
Ohio	1,200
Michigan	1,200
California	1,350

Proportion of line and tow. The statements in Table II on yields are made in terms of total rough fiber, but it should be remembered that the total fiber includes both the long fibers, called line or long line, and the short, tangled fibers, called tow. The line is worth from two to three times as much as the tow, and the larger the percentage of line fiber obtained, the more valuable the product. Regardless of how carefully hemp is handled, there will be some tow produced. In Wisconsin the mills usually produce 10 to 25 per cent tow and 75 to 90 per cent line. The amount of tow produced depends upon how thoroughly it is cleaned by the scutchers, how carefully the stalks are handled and how well they have been retted. Stalks under four feet in length will produce fiber that is practically all tow, and if the stalks have been under-retted, a very high percentage of tow will result. Tangled and unevenly butted stalks will also produce a high percentage of tow. If hemp is properly handled both by the grower and throughout the breaking process, there should result not over 10 to 15 per cent of tow.

One thousand pounds of Wisconsin's rough fiber will yield from 800 to 900 pounds of line, and from 100 to 200 pounds of tow. An average hemp crop in Wisconsin will yield three tons of well-retted and dried stalks to the acre. To produce such a yield the stand of hemp must be even, the growth regular, and the average height six and one-half feet. The three tons of dry, retted stalks will produce, on the average, 20 per cent by weight of rough fiber. A crop of hemp, therefore, that produces three tons of dry, retted stalks to the acre will give a yield of 1,200 pounds of rough fiber.

Green hemp stalks, at the time they are harvested, contain approximately 60 per cent more water than when they are retted and dry. Consequently a yield of three tons of dry, retted stalks represents a yield of seven and one-half tons of green material.

TABLE IV.—AVERAGE YIELDS OF GREEN STALKS, RETTED STALKS, TOTAL FIBER, LINE AND TOW

Material	Yield to the acre in pounds
Green stalks	15,000
Dry, retted stalks	6,000
Total fiber	1,200
Rough, long fiber	960
Tow	240

COST OF PRODUCING HEMP

It is impossible to arrive at accurate estimates of the cost of producing hemp, for in hemp as in the production of any other crop, the factors determining cost differ on each farm. In order to provide a general idea of the cost of producing hemp, the following statements, based on dependable data, are given.

Hemp is seeded in the spring. The land must be thoroughly prepared, and consequently, the cost of preparing the seed bed will be somewhat greater than for other spring seeded crops.

Hemp is seeded broadcast, as are most small grain crops. The cost of seeding, therefore, will be practically the same as for oats, barley, or wheat.

Hempseed is now (1917–18) expensive, ranging from $7 to $10 a bushel. Since a bushel is required to the acre, the seed will cost from $7 to $10 an acre, or an average of $8.50. It is evident that seed for the hemp crop is an expensive item compared with seed for planting most other farm crops.

After hemp is seeded, no cultivation or other attention is necessary until it is ready to harvest. In this respect the cost of production is figured on the same basis as for small grains.

The cost of harvesting will depend upon what arrangements are made for obtaining the hemp harvester. If one farmer grew from five to ten acres, and bought a harvester for his own crop only, the cost of harvesting his crop would be extremely high. If several farmers clubbed together and bought a harvester cooperatively, the expense of harvesting would be comparatively reasonable. One harvester should handle 100 acres of hemp so that cooperation among growers is very important. Where growers do not see fit to cooperate in the buying of a harvester, the company which operates the mill should purchase the necessary machines, furnish a man with each, and harvest the hemp at an agreed price.

A hemp harvester costs more than a grain binder; more power is required to pull it; and since it is a new device, more delays due to breakage are likely to occur. This means that the cost of harvesting hemp is, at present, somewhat greater than for harvesting a grain crop.

After the hemp is retted, it must be taken up from the swath and bound. This operation, called lifting, can now be done with the gather-binder, a machine devised for this particular purpose. By using such a machine, the cost of binding the retted stalks will be approximately the same as for threshing small grain.

After the stalks are bound, they must be shocked, a task that requires about the same amount of labor as does shocking bound corn.

The cost of hauling the dry, retted stalks to the hemp mill will vary according to the length of haul and the conditions of the roads. In estimating the cost of hauling, it may be considered that a good team will haul an average of 3,000 pounds to the load, which means that an acre of average hemp will make two loads of stalks.

When delivered to the mill, the hemp must be stacked. This requires about the same amount of labor as stacking bundled grain.

From these facts, it can be estimated that hemp compared with small grains costs from $5 to $7 more an acre for seed, from $2 to $3 more an acre for harvesting, and somewhat more for delivering, the total cost of production ranging from $8 to $11 more to the acre.

The total returns received are such that the net profits are much greater from hemp than from small grains—in fact, greater than from most other Wisconsin crops—a statement substantiated by the reports of a large majority of hemp growers in the state.

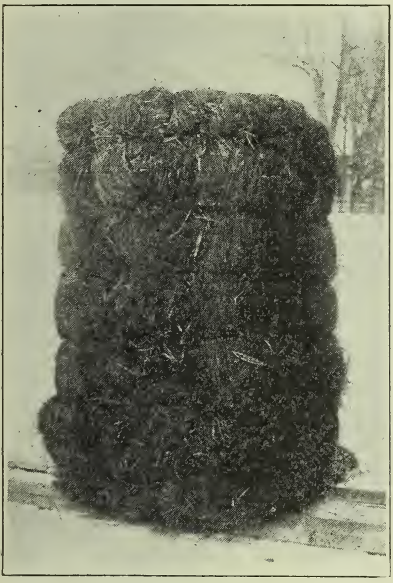

FIG. 19.—CLEANED HEMP FIBER IS BALED

Hemp fiber is pressed into bales about the size and shape of cotton bales.

RETURNS FROM HEMP

Wisconsin hemp growers are receiving most encouraging returns for the crop. Prices received during 1917 ranged from $50 to over $100 gross an acre.

These large returns are due, of course, to the present high price of hemp fiber and should not be expected to continue indefinitely.

However, the market outlook, considered from all points and from the supplies of competing fibers, indicates that for several years prices will remain higher than they were before the war.

So long as present prices for fiber continue the grower of hemp can expect to receive $75 an acre for a first-class crop of hemp. This does not imply that any field of hemp is worth $75 an acre for not all hemp is good hemp. Crops that are short, irregular, full of weeds, and poorly handled are of less value and may be nearly worthless.

PROCESSING THE HEMP FIBER

Before hemp fiber can be spun into yarn it must be either carded or hackled. Carding and hackling are combing processes, both of which are now done by power machines at the spinning mills. These processes remove all foreign materials and reduce the fiber to finer uniform strands. Formerly a large proportion of the best hemp in Kentucky was hackled by hand, and there are still two or three mills in that state where hand hackling is continued on a reduced scale. The fiber hackled by hand results in the Kentucky single-dressed and Kentucky double-dressed hemp still quoted in the market. One or two of the local dealers also have cards for preparing carded hemp, which is usually prepared from the medium grades or tangled hemp that would not command a first-class price as line fiber.

BUYING AND SELLING THE CROP

In Wisconsin the breaking and cleaning of hemp has become a specialized business, separate from the production of the crop. Consequently, the grower concerns himself only with the growing of the crop and the delivering of the retted stalks, and the mill operator attends to the breaking, scutching, and baling. As a result of the two separate phases of the industry, several methods of buying and selling the crop have developed. None of these methods are entirely satisfactory.

Buying the retted stalks by the acre is the most common method. The owner of the hemp mill will examine the farmer's hemp field, estimate the yield of retted stalks, note their condition and make a rough estimate of the quality of fiber they will produce. He then makes a bid on the crop, offering a certain price for the stalks when delivered at the mill. Such a method necessitates a great deal of bickering and is not good business for either the grower or the buyer.

Buying the retted stalks by the ton is another method in common use. When bought in this way, the dealer inspects the grower's crop and makes him an offer based on the length, evenness, and quality of the stalks with the understanding that the stalks are to be delivered to the mill in good condition and reasonably free from moisture. This method is much more business-like, but since the amount of moisture in different lots of hemp stalks varies greatly, disagreements and misunderstandings are sure to result. If there were a simple way of determining the amount of moisture in each load, and its value were computed on that basis, the method would then be much more satisfactory.

In a third method in common use, the grower delivers his crop to the mill where it is broken, cleaned and baled, and the grower either pays the mill an agreed price a pound for the work, or the mill buys the fiber at an agreed price. This method of dealing, based on the actual amount of fiber produced, should do away with most misunderstandings and disagreements. The objections to such an arrangement are that the majority of growers prefer either to receive pay for the crop, or to know how much they are going to receive at the time the crop is delivered; they object to storing the crop at the mill to await the time when the crop can be broken out, which is often several months. Such a method also works a hardship on the mill, for storage room must be provided, each man's crop marked and kept separate, and each crop broken out and handled as a separate lot.

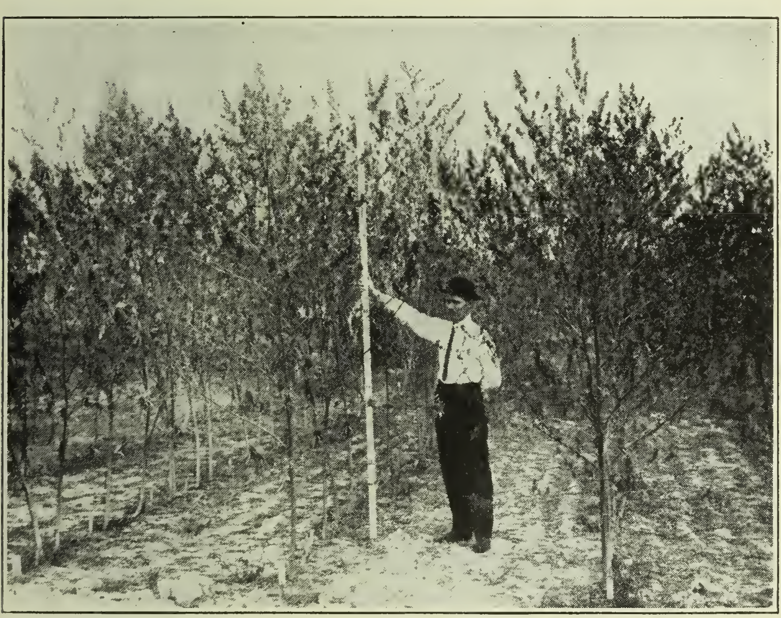

FIG. 20.—GROWING HEMP FOR SEED

For seed production hemp is planted in hills and cultivated like corn. The Experiment Station has made some progress in developing a strain of fiber hemp that will mature in Wisconsin. (Office of Fiber Investigations, U. S. D. A.)

It is difficult to state at this stage just what is the best arrangement for buying and selling the hemp crop. The industry is new and rapidly developing and these matters must be worked out gradually.

NEEDS OF THE HEMP INDUSTRY

While more progress in the development of the hemp industry has been made during the last few years than in all previous years combined, yet there remain many important problems to be worked out.

The seed situation is very unsatisfactory. The price has been so unreasonably high and erratic that the very life of the Wisconsin hemp industry is threatened. Unless the seed market becomes stabilized and the price reasonable, it will be necessary to develop new areas of seed production, and for the Wisconsin hemp growers to contract for seed acreages. The Experiment Station, in cooperation with the Federal Office of Fiber Investigations, has already made preliminary arrangements for the development of such new centers of production and such work must be continued as vigorously as possible. In the meantime everything possible must be done to develop or discover a variety of fiber hemp that will mature in the state. The Station has already made considerable progress along that line, encouraging results have been obtained, and by a continuation of such work,

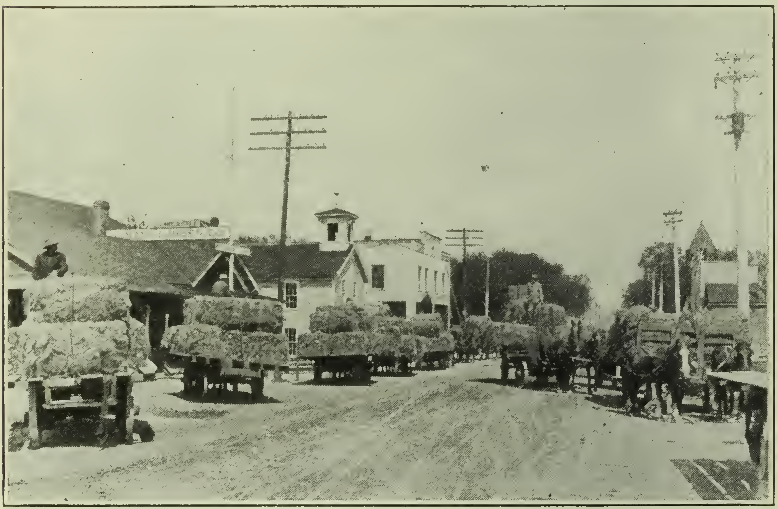

FIG. 21.—WISCONSIN HEMP READY TO SHIP

The bales of hemp fiber are sent to spinning mills and binder twine plants.

it may be possible to solve, finally, the whole troublesome seed problem.

There should be a standard market classification for Wisconsin fiber. Quantities sufficient to warrant such a classification are now being produced. To accomplish this, both growers and dealers in the state must realize that there is good fiber and poor fiber. The grower must learn how to handle the crop in order that the best quality of fiber may be produced, and the operators of breaking mills must learn to know hemp fiber, to differentiate between the general grades, and to handle the breaking and cleaning processes in such a way that the fiber will be in the best possible condition for further processes.

Farmers have learned rapidly to grow and handle the crop, but they are giving too little attention to keeping the stalks straight and the butts of the bundles even, and they have often neglected the retting. The more the stalks are crossed and tangled, the more tow will be produced. Uneven butts reduce the length of the line, and consequently decrease its quality. Improper retting is causing a great deal of trouble and if continued is sure to affect the market price. Under-retting is entirely too common. Farmers are usually very anxious to gather up the hemp stalks to avoid the danger of their being "snowed under" for the winter, and often take them up, bind and shock them two weeks or a month too early. It should be remembered that the stalks should be left spread out until the green color has entirely disappeared and until the fiber will readily peel away from the woody part of the stems. By giving attention to these important details the grower can do much towards insuring a stable and profitable market, a matter which is as important to him as it is to the mill operator.

More attention should also be given to handling properly the hemp stalks at the breaking mill. There is too much careless handling of the stalks in preparing them for the dry kiln and in delivering them to the brake after they are dried, all of which increases the percentage of tow and reduces the quality and quantity of long line fiber. The stalks should be butted carefully before they are fed to the brake, and the uncleaned fiber should be delivered to the scutcher in such a way that the butt ends of the broken material will be as even as possible throughout.

Great progress has been made in devising breaking and scutching machinery, but there is still room for improvement. The greatest need right now is for an improved scutcher, one that will remove practically all the hurds from the fiber and will not produce such a large percentage of tow. Much attention is now being given to producing such an improved scutcher and there is every reason to believe that one will soon be available.

ACKNOWLEDGMENTS

Acknowledgment is hereby made to State Commissioner of Agriculture, C. P. Norgord, who, as a member of the Agronomy Department, was chiefly responsible for the early development of the hemp industry in this state and who carried it through the experimental stage; to R. A. Moore, Professor of Agronomy, who initiated the work with hemp and who has faithfully guided and supported it throughout; to L. H. Dewey of the United States Department of Agriculture, who has cooperated with the Agronomy Department of the Experiment Station in all hemp investigations, who has furnished financial assistance, and who has reviewed the manuscript of this bulletin and furnished the photographs for many of the illustrations used.

Acknowledgment is also due to that faithful group of farmers at Waupun, formerly constituting the membership of the Rock River Hemp Growers' Association whose persistent efforts are considerably responsible for tiding the new industry through the pioneer stages; to H. L. Daniels, and J. L. Barrett of the International Harvester Company, who made possible the construction of the new hemp harvester and the gather-binder and supplied photographs of these machines and who have assisted the Wisconsin industry in every way possible; to J. L. Andreas of Pierceton, Indiana, who devised successful machinery for driving and breaking hemp stalks and for cleaning the fiber; and to the members of the Wisconsin Hemp Order, who have rendered valuable service in furthering the interests of the industry.

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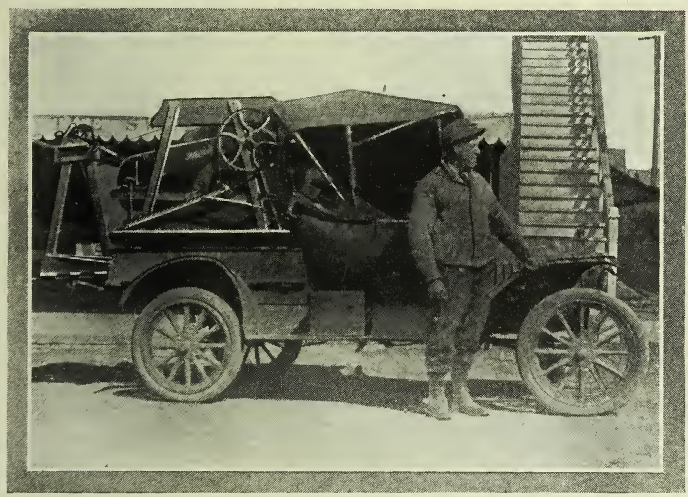
Bulletin 294 July, 1918

Serving Wisconsin Farmers in War Time

(Report of the Director of Agricultural Extension Service)

H. L. RUSSELL AND K. L. HATCH



READY TO RENDER PRACTICAL HELP

Wisconsin county agents are always ready to lend a helping hand. This agent has loaded the fanning mill and the smut machine on his car and is starting on a trip to treat grain for smut.

EXTENSION SERVICE OF THE COLLEGE OF AGRICULTURE
THE UNIVERSITY OF WISCONSIN

MADISON

CONTENTS

Page

County representative system advances ---------------------- 3
  Farmers realize the nation's need ---------------------- 4
Special production and food conservation campaigns---------- 5
  Seed corn secured and tested ---------------------- 5
  Spring wheat acreage increased ---------------------- 5
  Vigorous campaign increases silo construction ---------- 6
  Land clearing augments acreage ---------------------- 7
  Redistribution of live stock ---------------------- 7
  Food conservation measures popular ---------------------- 9
  Publications issued as a result of war conditions-------- 9
Potato improvement work ---------------------- 11
  Certification of potato seed stock ---------------------- 11
  Potato disease control ---------------------- 12
Orchard management demonstration ---------------------- 12
Start landscape design work ---------------------- 13
Testing for tuberculosis on increase ---------------------- 13
Examination of pathological specimens ---------------------- 14
Hog cholera serum production ---------------------- 14
Surface drainage, a wartime necessity ---------------------- 14
  Tile drainage reclaims idle acres ---------------------- 15
Soil examinations tell soil troubles ---------------------- 16
Soil management ---------------------- 16
Farmers' meetings continue in popularity ---------------------- 18
Farmers' and womens' weeks ---------------------- 19
Boys' and girls' clubs aid food production campaign---------- 20
Livestock improvement grows apace ---------------------- 21
  Official tests increase ---------------------- 21
  Breeders' associations are organized ---------------------- 21
  Hold sheep growers' meetings ---------------------- 22
  Stimulate baby beef production ---------------------- 22
  Focus on swine production ---------------------- 23
  Livestock exchange ---------------------- 23
Wisconsin dairy herds selected for service---------------------- 24
Inoculation of peas increases production ---------------------- 26
Millers and bankers cooperate with college in bread drive---- 28
  Bankers lead in pedigree wheat distribution ------------- 29
  "The pure seed and home power special"---------------- 29
Dairy demonstrations control factory losses------------------30
Farmers interested in keeping accounts ---------------------- 31

Serving Wisconsin Farmers in War Time

COUNTY REPRESENTATIVE SYSTEM ADVANCES

The county agents rendered valuable war service. When the call for more food came, the county agent was on the ground with the knowledge of the war time needs of his county and the country.

The war found Wisconsin with 19 county agents—the end of the year (June 30, 1917) saw the number increased to 27. Six other counties had provided the means for starting county agents. Upon the declaration of war the College of Agriculture released members of the teaching staff to take up work similar to that of the county agents in the unorganized counties. On August 16 Congress provided additional federal funds which made it possible for the college to maintain in the field throughout the summer 27 additional men as emergency food agents.

It has been customary to publish the results of the College of Agriculture of the Experiment Station and the Extension Service work in a combined annual report. Owing to the press of work in the executive office caused by absence of some of the staff members engaged in war service, it has been impossible to prepare promptly the results of both types of work for simultaneous publication. Consequently, the work of the Extension Service is here presented separately.

These emergency food agents together with the organized county agents made a total field staff of 54 men and gave an almost complete state-wide organization with which to carry on vigorous campaigns for increased food production. Valuable service was rendered. More and better potatoes were raised; better seed grain was bought by the farmers; every possible effort was put forth to make each stroke of work accomplish the greatest result in increasing the nation's food supply.

FARMERS REALIZE THE NATION'S NEED

Our famers are rapidly coming to realize their responsibility in supplying food to the people at home, to the boys in the trenches, to our allies, and others dependent upon this nation for food. Farmers understand that because they feed the world their work is fundamental. They know farm conditions have changed since the war began and that it is their patriotic duty to increase the yield of farm crops. They feel that greater care must be exercised in the elimination of waste and

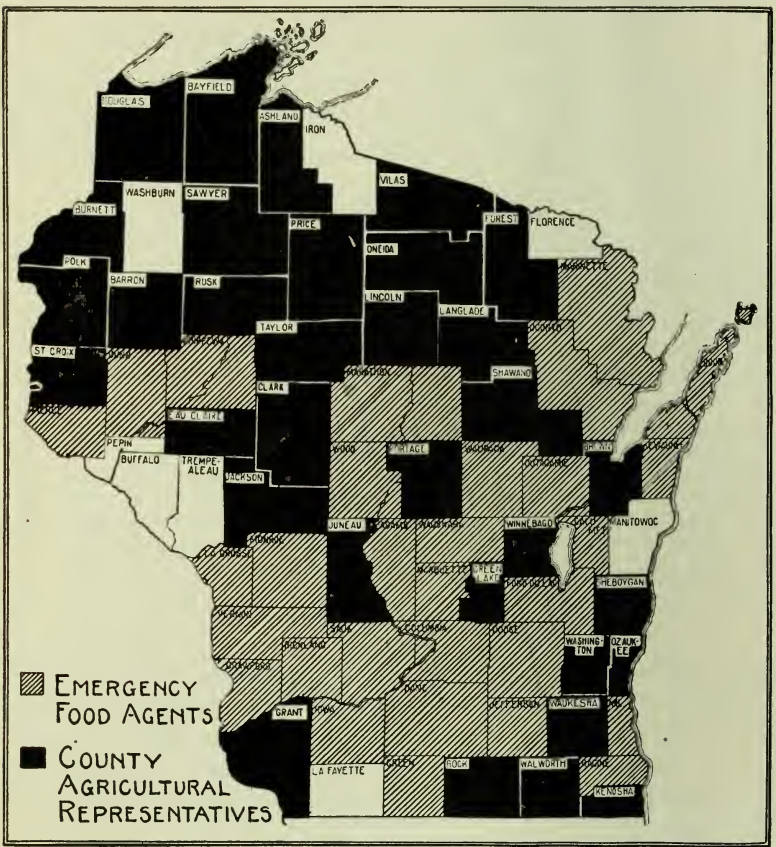


FIG. 1.—ORGANIZED FOR BETTER AGRICULTURE

The production of food is one of the most important civilian services of the war. Nearly all counties in the state are provided with agents whose business it is to assist in providing food for our soldiers at the front.

in the control of preventable losses and that better judgment must be used in the marketing of their produce. They also realize that they must "do better the things that they know best how to do."

SPECIAL PRODUCTION AND FOOD CONSERVATION CAMPAIGNS

SEED CORN SECURED AND TESTED

Immediately after declaration of war, agricultural agents were requested to make seed corn surveys. Farmers who were in need of seed corn were put in touch with those who had more than they needed. A vigorous campaign for the testing of seed corn was carried on through the schools. Seed corn was secured and tested, and the acreage was increased about 5 per cent. Owing to adverse conditions of weather during the summer and early fall, less than 1 per cent of the crop of the past season fully matured. About 52 per cent was harvested for silage. There was saved for seed corn about 100,000 bushels, due largely to the special campaign made by the agricultural representatives.

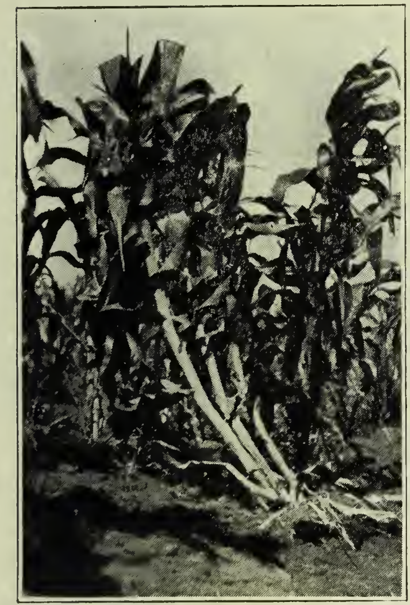


FIG. 2.—THE WORK OF THE CORN ROOT WORM

Crop rotation entirely prevents this injury as the corn root worm feeds only on the roots of the corn and is starved out when other crops are sown.

SPRING WHEAT ACREAGE INCREASED

Vigorous effort was made in cooperation with the State Department of Agriculture and the County Councils of Defense to assist farmers in securing the necessary supply of seed wheat in the spring. As a result an increased acreage of 36 per cent was secured with an increased yield of 55 per cent. The campaign for increasing the fall wheat acreage resulted in an increase of 11 per cent and the fall rye acreage was increased 6 per cent.

SEED POTATOES DISTRIBUTED

Similar campaigns were instituted in a number of counties by the County Representatives to supply the potato seed needs of the state. Over 200 carloads of seed stock were distributed through the medium of the State Department of Agriculture. An increased acreage of 10 per cent was secured which resulted in a total yield of 36,420,000 bushels for the state, about 7,000,000 bushels above the normal crop. This was the second largest crop ever harvested in the history of the state.

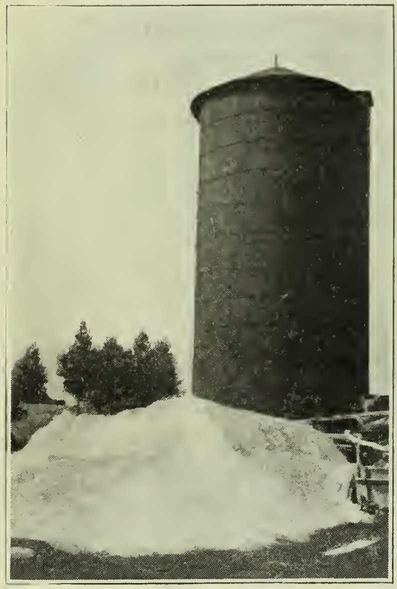


FIG. 3.—THIS SHOWS PROGRESS

Silos to save corn, and lime for alfalfa are urged by all emergency agents. This is a Green county result.

VIGOROUS CAMPAIGN INCREASES SILO CONSTRUCTION

A silo campaign was carried on during the early spring and summer. Demonstration meetings were held in every county under the direction and with the assistance of members of the agricultural staff. To this campaign Wisconsin newspapers gave liberal support. The banks also assisted by making it easier for farmers to borrow money to build silos. As a result of this systematic campaign, about 10,000 additional silos were built by farmers of the state during the past year. This record makes the aggregate number of silos in the state about 70,000 and enables Wisconsin to maintain the position which it has long held of having more silos than any other state in the union.

LAND CLEARING AUGMENTS ACREAGE

Sixteen one-week Land Clearing Demonstrations aroused widespread interest among farmers and other settlers in upper Wisconsin. It was a practical and educational campaign conducted under the leadership of the agricultural college. The efficiency of the hand and power stump pullers and low grade dynamite in land clearing was demonstrated.

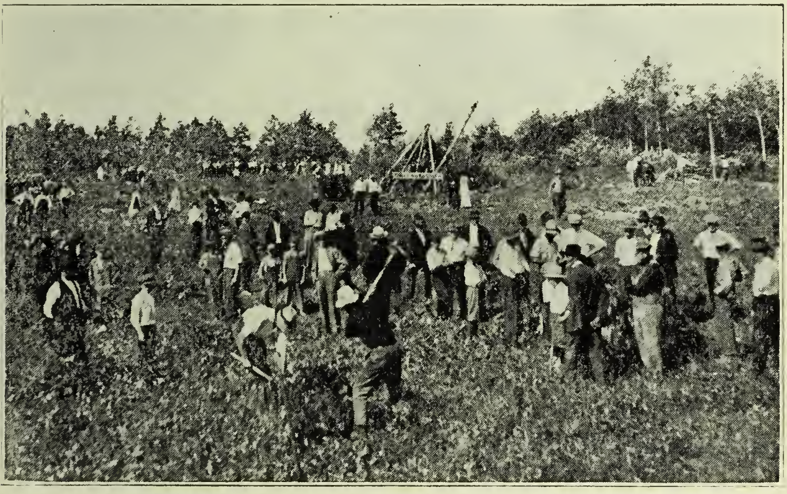


FIG. 4.—WATCHING NEW CLEARING METHODS

The acreage of farm land is being expanded in upper Wisconsin through demonstrating to the settlers better and easier methods of clearing the fertile soil.

In many instances several farmers joined in the purchase of a machine and are using it jointly on a cooperative plan and whole communities united in the purchase of dynamite in carload lots. It was clearly demonstrated that the combination of the machinery (both pullers and pilers) and dynamite is the most efficient method of clearing land.

REDISTRIBUTION OF LIVE STOCK

The dairy industry is undergoing unusual development in this state. The work of the cow testing associations, the improvement of grade stock through the introduction of purebred sires, the raising of suitable crops for feeding, the building of silos and the construction of better dairy barns—all of these factors have brought about the production of a more profitable dairy cow.

As a result, Wisconsin is now enjoying a nation-wide reputation for its livestock, especially in the dairying field. With the assistance of the county agricultural agents, the livestock associations, and other extension workers, buyers from outside the state are enabled to secure purebred and high grade livestock quickly and economically.

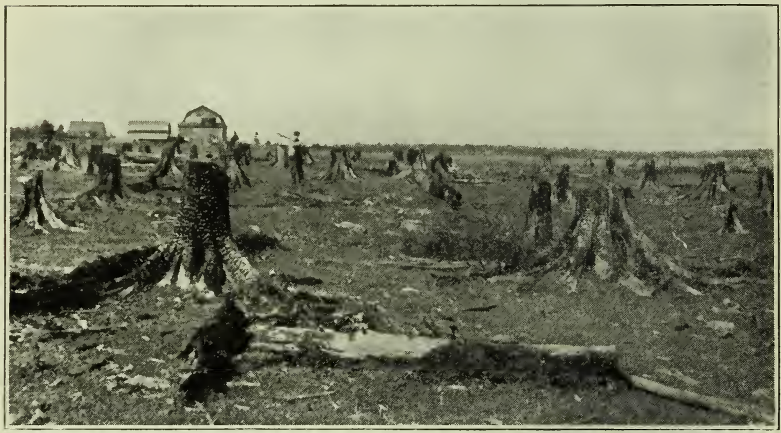


FIG. 5.—A VIRGIN SOIL AWAITS THE SETTLER

A typical scene. White pine stumps on clay loam soil ready for stumping.

In one county alone, 18 carloads of heifer calves less than a year old were sold and shipped to out-of-state buyers. From another county 13 carloads of dairy cows were exported. A total of 150 carloads of livestock worth approximately $300,000 was marketed in this manner during the past year. Every effort was made to save good dairy calves from slaughter.

The early freeze and the consequent injury to the corn crop forced farmers to sell their pigs before they were ready for market. The state was immediately organized for the transportation of these pigs to the corn belt to be fed out on the soft corn of that section. As a result of quick and effective organization hundreds of cars of shipper pigs were saved from early slaughter, and millions of pounds of pork added to the nation's supply.

FOOD CONSERVATION MEASURES POPULAR

Special stress has been laid on the conservation of foods through the work of girls' clubs and special demonstration workers in home economics.

A large number of canning demonstrations were held throughout the state, with from 25 to 50 women present at each meeting. In one county 20,000 pounds of fruits and vegetables were canned during the summer. Pears, beans, swiss chard, blueberries, rhubarb, cauliflower, carrots, tomatoes, beets and other fruits and vegetables were canned. In addition, drying, pickling, and preserving were widely advocated.

FIG. 6.—STUMPING DEMONSTRATIONS INTEREST SETTLERS

As a result of the land-clearing demonstration at Holcombe, this group of settlers is cooperating in the clearing of 100 acres this year.

The department of home economics early in the year began advocating the use of war breads and by bulletins, lectures, and demonstrations secured their wide-spread adoption and use.

PUBLICATION ISSUED AS RESULT OF WAR CONDITIONS

The publications issued by the College of Agriculture as a result of war conditions include 24 circulars, 8 emergency posters, 5 stencil bulletins and 8 miscellaneous pamphlets, representing a total of 1,226,000 pieces of matter distributed among the people of the state.

Circulars

62 A Farmer's Poultry House
63 The Care of Milk and Cream on the Farm
64 Have You Had Your Soil Analyzed?
65 Sewing for Girls
66 Crate-Feeding Poultry for Market
67 Cow Testing Pays
68 Canning for Pleasure and Profit
69 What to Feed the Children
70 Fight Fire Blight of Apple
71 Grow Beans
72 Have a Backyard Garden

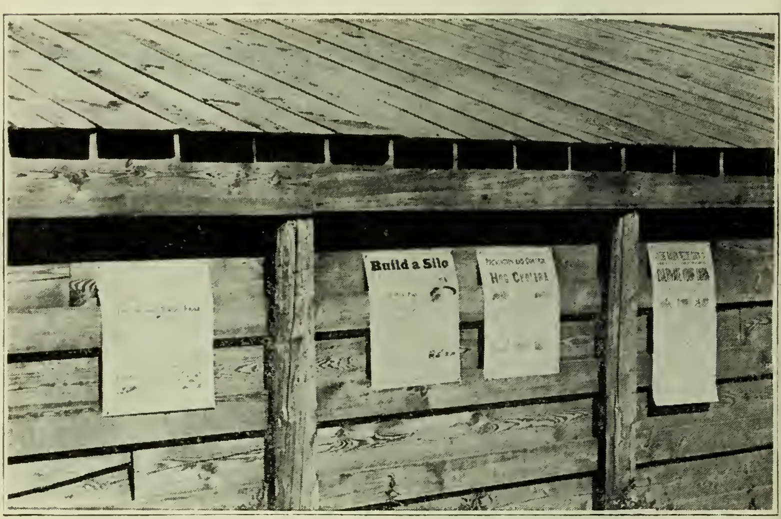


FIG. 7.—POSTERIZING GREEN COUNTY

Posters, bulletins and circulars have been effective tools for County Agents and Emergency Food Agents in their work.

73 Start a Flock
74 Preserve Spring Eggs for Winter Use
75 Why Buckwheat
76 Getting the Farm Work Done
77 Drain the Wet Spots
78 Kill the Worms and Save the Apples
79 How to Cook Soybeans
80 How to Use Barley
81 The Moisture Test in the Cheese Factory
82 Defend Your Garden Against Insect Pests
83 Fighting the "Potato Bug"
84 Cultivation Counts
85 Stack First—Then Thresh

Stencil bulletins

15 Sheep Raising Pays
16 The Moisture Content of Wisconsin Cheese in 1916
17 Why and How to Disinfect Seed Potatoes
18 Suggestions for Planning the Home Grounds
19 Growing Potatoes in the Garden and on City Lots

Emergency posters

1 Serve the Nation
2 America Needs Wheat
3 Have a Back Yard Garden
4 An Army of Poultry Will Help Win the War
5 An Acre of Roots Will Help Winter Your Stock
6 Build a Silo

Leaflets and folders

Defend Your Dairy Profits—Build a Silo
Fresh Eggs
Keep Milk Cool and Clean
Profitable Mutton and Wool Production

POTATO IMPROVEMENT WORK

J. G. Milward (horticulture) has concentrated his entire energies on potato improvement work and with the assistance which he has been able to secure as secretary of the State Potato Growers' association from the commercial growers, as well as the dealers, great advance has been made in this state in the last five years. Many county and community growers' associations have been organized which have for their object the elimination of the numerous undesirable strains of seed stock. Today whole communities are growing pure strains of two or three varieties selected with special reference to soil and climatic conditions, thus doing for the potato industry what purebred cattle and pedigreed seed have accomplished for the development of livestock and grain.

Potato clubs have been formed in the schools. Spraying demonstrations and special potato meetings have been held at more than 40 points and attended by 3,500 growers. The annual convention of the Potato Growers' association was held this year at the University. In spite of the severe freeze which seriously injured the crop in many sections, the potato show was the best ever held in the state.

CERTIFICATION OF POTATO SEED STOCK

During the year applications were received from 172 growers to have their fields of seed stock inspected for certification. The cost of this inspection is charged to the growers benefited, the same as in the official testing of dairy cattle. Eighty-two certificates certifying that their inspected stock was not only pure as to variety, but free from disease were granted to the growers.

POTATO DISEASE CONTROL

Supplementing the cultural and seed improvement has been the very active work of the plant pathology department in the control of potato diseases.

Reports from 82 farmers who treated their seed this year with either formaldehyde or corrosive sublimate show, where there was an opportunity for field comparison, that a better stand was obtained in 22 cases, while in 33 fields no difference was observed.

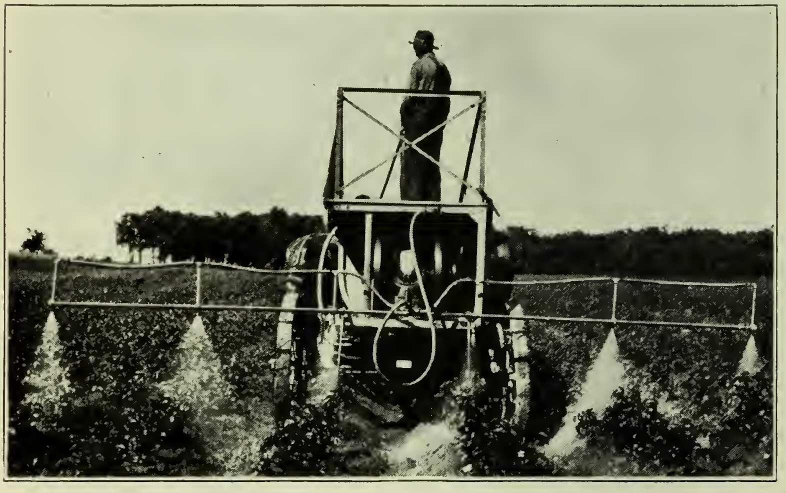


FIG. 8.—AN EFFECTIVE SPRAY ATTACK

The spraying of potatoes against bugs and blight is one of the most important food conservation measures.

Treated and untreated seed was planted side by side on the same kind of soil and handled in the same way. The crop from the treated seed gave very little scab and only slight infections, while the crop from the untreated seed was very scabby (about 40 per cent) and the spots very deep. In only one case was there a poorer stand where the seed was treated.

Orchard Management Demonstration

Work has been continued this year on demonstrating and showing the advantage of spraying and pruning orchards and special field instruction has been given in packing methods with R. H. Roberts (horticulture) in charge. It is significant that spraying machines have been purchased in nine different communities as a direct result of these meetings.

The apple shipping centers of Bayfield and Sturgeon Bay are evincing a healthy desire to improve the quality of their fruit pack. Packing demonstrations, both barrel and box packs, were given at both these places and at Gays Mills.

START LANDSCAPE DESIGN WORK

A beautiful environment exerts a subtle influence on the upbuilding of character and has a far reaching effect on the rural life of the state.

With the addition of our force of F. A. Aust, our horticulture department has been able to meet the increasing demand for aid in the problems of beautifying the surroundings of the home. This line of extension activity was organized to give farmers and others of the state assistance in beautifying their farm surroundings and aid in making their homes more attractive. Illustrated lectures have been given in ten different cities. Planting plans for public buildings have been furnished for demonstration purposes to five localities.

TESTING FOR TUBERCULOSIS ON INCREASE

Year by year there is a steady growth in the demand for tuberculin which is made for diagnostic purposes by the department of bacteriology and is utilized in cooperation with the veterinary division of the State Department of Agriculture as well as special tuberculins for the optthalmic, intradermal and avian tests. In 1914–15, 51,300 doses were furnished the state department; last year 77,500 doses; while this year 106,250 doses, over 37 per cent increase over the high figure of the previous year, were used by them.

Particular efforts have been made to keep tuberculosis out of the rapidly developing dairy region of upper Wisconsin. The agricultural representatives in 12 counties tested 1,740 head last year and found only 15 reactors. In one county where 10 reactors were discovered six were found in purebred herds, showing how the purchase of improved stock is the entering wedge through which this disease is insidiously forcing its way into the new north.

If general testing can be had in this region, the breeders in that section will soon be able to reap the very considerable advantage which will come from their ability to advertise dairy stock from a tuberculin tested region.

EXAMINATION OF PATHOLOGICAL SPECIMENS

The veterinarians of the state are making ever increasing use of the facilities of the veterinary science department laboratory for the examination of specimens, and the diagnosis of animal diseases. During the year 318 samples have been examined, an increase of 60 per cent over that of the preceding year. One hundred and forty-two veterinarians, or nearly 40 per cent of the entire profession of the state, availed themselves of the laboratory, for the examination of pathological specimens, the testing for contagious abortion, or the application of hog cholera serum. One case of importance to the human developed in a sample of tissue suspected of anthrax, in which the attending veterinarian acquired a severe infection. On the strength of the diagnosis, anti-anthrax serum was utilized with success.

HOG CHOLERA SERUM PRODUCTION

Hog cholera serum to the amount of 1,020,260 cubic centimeters has been produced by the veterinary science department during the year, 870,460 cubic centimeters having been sold and used in connection with the preventive treatment of this disease on over 20,000 head of swine. The business transacted in the sale of the serum and by-products amounted to $15,329.81.

Owing to the sharp advance in the price of pigs used in the manufacture of hog cholera serum, it was necessary to raise the price of this material to cover the cost of production.

SURFACE DRAINAGE, A WARTIME NECESSITY

Special emphasis this summer has been given to the matter of surface drainage on account of its immediate influence on the productivity of wet clays. O. R. Zeasman (soils) spent two weeks in the flat country in Wood, Chippewa, and Marathon counties, demonstrating the use of the V-shaped ditcher.

As a result, four communities have purchased machines, thus equipping themselves to make surface runs as outlets for dead furrows to be used in connection with fall plowing. A steady increase in the use of tile where demonstrations under farm drainage conditions have been held, is noted. At Wayauwega more than ten carloads of tile have been laid as a direct result of a tile system installed on the farm of Mr. Wall.

Owing to the shortage of labor at present, the development of large areas of marsh land which requires expensive operations for ditching and tiling is likely to be delayed. But the importance of securing good surface drainage on all lands under cultivation is even greater than under normal conditions.

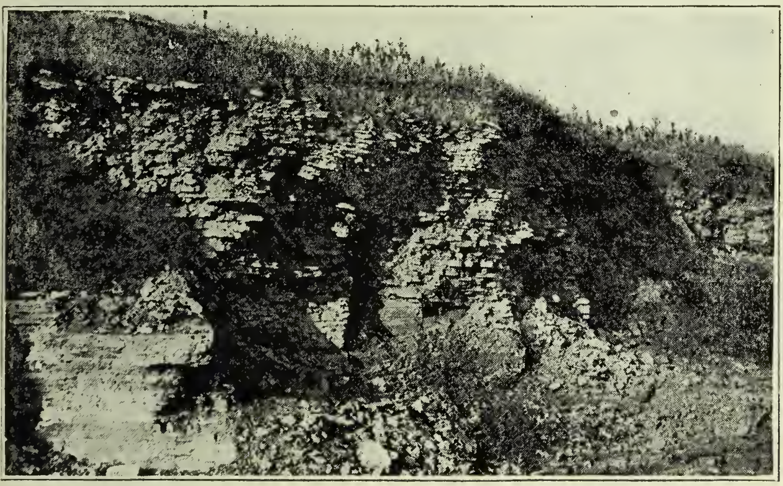


FIG. 9.—LIMESTONE TO CURE SOUR SOILS

Where the haul from the railway is long the grinding of limestone in local quarries is the cheapest way to secure lime for sour soils. The Emergency Agent in Green county located several of these rich, high-test limestone quarries.

TILE DRAINAGE RECLAIMS IDLE ACRES

Tile drainage has now developed to such an extent in the southeastern part of the state that further demonstrations in this section do not appear to be necessary. This year emphasis has been laid upon the work particularly in the northern and central parts of the state, where the farmers have not previously given much attention to this form of land reclamation.

Interest in drainage in Waupaca, Outagamie, Green Lake, Fond du Lac, Dodge, and Columbia counties is particularly keen.

Sixty-three farm projects have been undertaken, involving a preliminary survey in 51 cases aggregating 2,700 acres and 12 final surveys of 280 acres. Assistance has been given to 42 organizations during the year; in 12 cases preliminary surveys have been made, involving the improvement of 14,500 acres, and 26 field examinations of old and new organizations, embracing over 40,000 acres. As required by law, reports on the soil and drainage conditions have been prepared in 17 drainage districts. Fifty-eight meetings have been held with an attendance of 3,400 people, at which discussion of drainage work in the immediate vicinity has been presented. Twenty-three follow-up demonstrations with an attendance of 350 farmers, have been given in the field, for direct observation of the benefits of tile drainage system which had been installed the previous year.

SOIL EXAMINATIONS TELL SOIL TROUBLES

During the year the State Soils Laboratory (A. R. Whitson in charge) has made 336 analyses of soil samples requiring 1,367 determinations. These samples were collected from 154 different farms which have applied for this service.

This work has been found very helpful in connection with the other extension and research work of the college. In a number of cases examination has been made at the request of prospective purchasers who have availed themselves of the advantages of the laboratory to secure reliable information regarding the character and value of the soil.

SOIL MANAGEMENT

The problems of soil management continue to employ a large part of the time of the soils department. Efforts this past year have been specificially directed toward the organization of community clubs that have for their specific object the consideration of soil improvement problems. In the southern part of the state W. W. Weir has given special attention to the use of lime as a corrective of soil acidity. In the vicinity of Prairie du Chien pulverized clam shells as a source of lime are now employed. Heretofore these have been considered as a waste product, but their value in improving the condition of the soil as a prerequisite to successful alfalfa growing indicates that from now on they will be utilized for the correction of soil acidity. At Edgerton, Sinsinawa, and Rock Prairie, through the medium of cooperative effort, farmers have purchased machinery for crushing and pulverizing local limestone, which is abundant and is much needed to counteract the acidity of the soils in these sections.

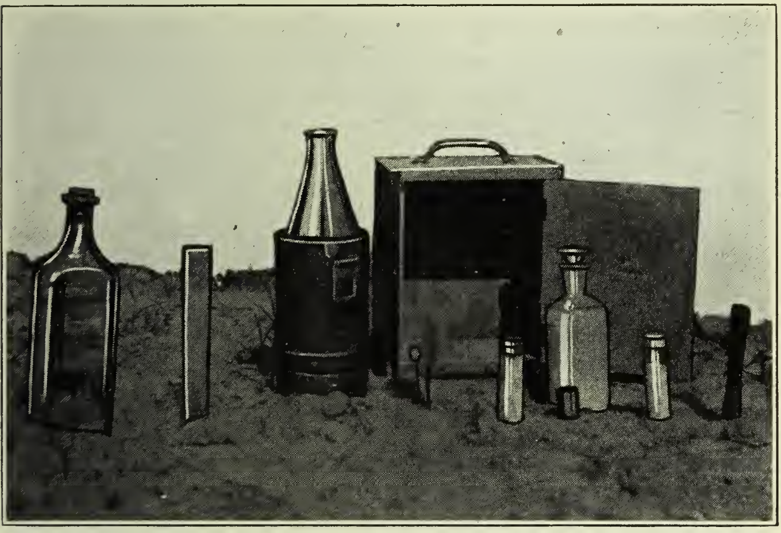


FIG. 10.—TRUOG SOIL TESTER FORMS PART OF FIELD EQUIPMENT

The emergency food agents have found the Truog soil acidity test a valuable aid. The small tester is a most essential part of his outfit in the field.

F. L. Musbach has had charge of the work in the northwestern part of the state and has carried on nine individual demonstration plots from a half acre to one acre in extent, aimed to demonstrate specific lines of soil treatment, such as the use of phosphatic fertilizers, either with or without stable manure and lime treatment.

Seven larger demonstration areas have also been instituted where a more or less complete series of fertilizer demonstrations have been carried out on a wide range of soils, varying from crude peat to newly drained land and the light sandy soils found in the vicinity of Hayward and in portions of Barron county. While the price of fertilizer at the present time is unusually high on account of the war, very profitable returns have been secured where even limited amounts of chemical fertilizer were employed. At Phillips 200 pounds of acid phosphate and 150 pounds of sulphate of potash on potatoes increased the crop from 258 to 396 bushels an acre, or 138 bushels at a cash outlay for fertilizers of $11.28 an acre. It was noteworthy that the percentage of cull stock was twice as much in the unfertilized as in the fertilized field. On sandy soil at Hancock where the check plots produced only 4½ bushels of rye to the acre, an application of fertilizer costing $4.50 an acre resulted in an increase to 15 bushels an acre.

As a result of these and other demonstrations many carloads of lime and fertilizers have been purchased by farmers. In the neighborhood of Almond six carloads were shipped in and over 100 acres of alfalfa have been started as a result of the work done last year.

In all, 64 demonstrations were held with a total attendance of 9,100 people.

FARMERS' MEETINGS CONTINUE IN POPULARITY

The activities of the Farmers' Institutes under the superintendent, E. L. Luther, and his staff have been more widely extended and specialized this year than ever before. Besides the regular two-day institutes, of which 126 were held with an aggregate attendance of 63,770 people, 52 women's meetings and 17 one-day institutes have been carried on, and, in addition, special feature institutes embracing the consideration of the problems incident to the light sandy soils in the central part of the state, drainage, livestock, and cow testing meetings. During the summer, field demonstration meetings have been extensively carried on and 403 meetings of various types embracing an attendance of 108,700 people have been had. The special feature meetings have been found to be of particular value. They focus the attention of the community on a single problem chosen with particular reference to the needs of the section. As a result of the interest taken in alfalfa work at Friendship, Adams county, the winter before, nine farmers secured lime and planted alfalfa on properly neutralized and prepared soil. During the summer field meetings were held on the farms where this work had been done so that all could see just how successful the treatment had been in the community. Many community organizations (farmers' clubs, growers' organizations of special crops, such as potatoes, baby beef, cow testing and poultry) have developed as an outgrowth of the institute work.

FARMERS' AND WOMENS' WEEKS

The Farmers' and Womens' weeks fully described in our last report have continued to grow in influence and favor, under the active leadership of R. F. Murray for the men and Miss Agnes Boeing for the women. There were held during the season just closed a total of 24 one-week meetings for farmers and 18 meetings of the same length for the farmers' wives and daughters, attended by more than 28,000 people. This represents an increase of 28 per cent in number and 30 per cent in active interest over last year.

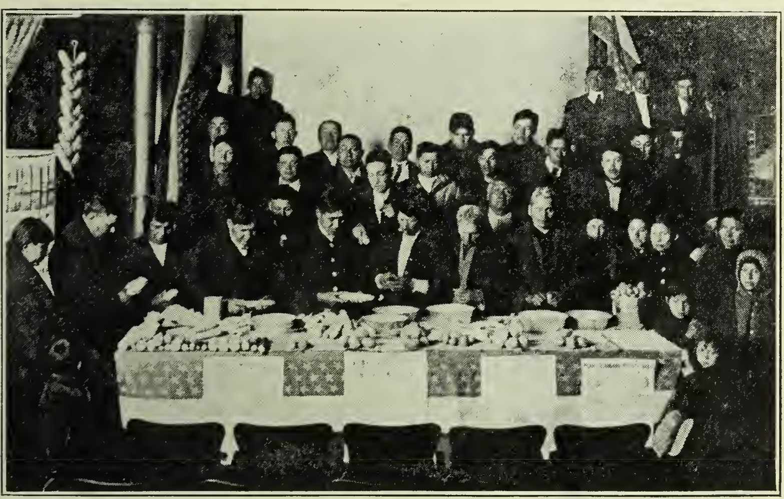


FIG. 11.—INDIANS BELIEVE IN BETTER FARMING

The original owners of America are helping win the war by studying and practicing better methods of agriculture.

The Indian Farmers' Institutes have continued to grow in popularity. Meetings were held at the Menomonie and Bad River reservations and at Mauston and Black River Falls, which were attended by 500 Indians.

BOYS' AND GIRLS' CLUBS AID FOOD PRODUCTION CAMPAIGN

Nine hundred young people were enrolled in the acre corn growing projects carried out in the Boys' and Girls' Club work in cooperation with the United States Department of Agriculture, (T. L. Bewick in charge of boys' clubs and Miss Elizabeth Amery, of girls' clubs.) Though results came to almost nothing because of the early freeze, several of these young people succeeded in maturing and saving a considerable quantity of good seed corn.

FIG. 12.—AWAITING THEIR TURN

Boys' and Girls' club members watching the seniors marching to receive their diplomas. The club members gather each June at the College.

For the first time in Wisconsin, Junior Farmers' Institutes were carried on in six different localities. At Sturgeon Bay, an average of 250 boys and girls attended each session. Country schools were dismissed and some children drove 20 miles to be in attendance at this institute.

The young people's department at the State Fair showed a gain of 300 per cent in quantity of exhibits and a marked advance in quality.

In addition, 1,886 young people completed the growing of

⅛ of an acre or more of potatoes, 1,624 completed home garden projects, 603 girls canned $6,407 worth of fruits and vegetables, 2,556 carried on alfalfa work, 811 members raised $11,235 worth of poultry, 34 members raised 62,800 pounds of baby beef, 88 members fed 231 dairy calves, 164 boys and girls produced about 30,000 pounds of pork, 1,138 girls competed in bread club work, 558 competed in garment making, and 149 enrolled in strawberry clubs.

Altogether 6,230 young people completed all the work outlined for the club to which they belonged and produced or saved food products aggregating a total of over $120,000.

LIVESTOCK IMPROVEMENT GROWS APACE

In no state of the Union are the agricultural organizations more closely united in the common object of promoting the best interest of agriculture. No energy is misspent on duplication of effort, and through cooperation of the College, the Wisconsin Live Stock Breeders' association, the Wisconsin Dairymen's association, and the various breed associations, it has been possible to secure results that no one organization could have accomplished alone.

OFFICIAL TESTS INCREASE

The official testing of dairy cattle, in charge of Roy Harris (animal husbandry), continues to increase in amount. During the peak load in the winter, 5 men were at work. Eighty-five hundred tests were made on 2,940 animals. The cost of this service is defrayed by fees received from the breeders themselves.

BREEDERS' ASSOCIATIONS ARE ORGANIZED

Community organization still continues to be the main effort of Wisconsin dairymen. The obvious advantage of a collective movement where an entire community bands itself together to advance one particular breed of livestock is being recognized better each year. Cattle owners find it greatly to their advantage to join these associations as each member gains in advertising prestige through this community movement.

Wisconsin has jumped to the front as the leading Guernsey state, and Waukesha county found herself possessing over 40 per cent of all the cattle of this breed in the state, a much larger number, even, than in the mother island of Guernsey. At the present time 120 special breeders' associations (53 Holstein; 43 Guernsey; 20 Jersey; 4 Shorthorn) have been formed, and also 14 general livestock groups, 19 draft horse and 3 swine associations.

With the economic impulse which these associations develop, many of these organizations have taken up cognate problems such as cooperative purchase of feeds, disease eradication, rural credits, farm home betterment, and other noteworthy projects, that have aided in making a better agriculture. Indeed it may be said that through this and related mediums, organized agriculture has become the dominant policy of Wisconsin farmers.

While the dairy cow will naturally receive the major part of the attention of Wisconsin farmers, special effort has been made this year to give an impetus to the development of other lines of livestock, particularly sheep, beef, and swine.

HOLD SHEEP GROWERS' MEETINGS

The ''golden hoof'' used to be popular in our Wisconsin farms, but of late years wider opportunity on the western ranges has led to a decline in sheep production. However, conditions have undergone a radical change and with the opening of large areas of available pasture on the cheaper lands in upper Wisconsin and the breaking up of the western ranges, Wisconsin farmers are again becoming interested in the sheep industry. Twenty-eight special sheep meetings have been held by Frank Kleinheinz (animal husbandry) principally on farms where sheep are actually being kept. They have stimulated greatly the interest in this industry and the coming year will see in Wisconsin more feeding of western lambs and ewes and more breeding of flocks than for many years in the past.

STIMULATE BABY BEEF PRODUCTION

In cooperation with the state livestock breeders' association special emphasis has also been placed on the production of baby beef. Interest was first stimulated through the medium of beef institutes. This was followed by the organization of

Baby Beef contests in which farm boys were encouraged to feed and care for the growing animal. Interest was developed by holding local contests at the county fairs, and a state contest in which 26 boys competed was held at the University in November. The quality of the show is attested by the fact that the winner here was placed as junior calf champion at the International Livestock show at Chicago a few weeks later.

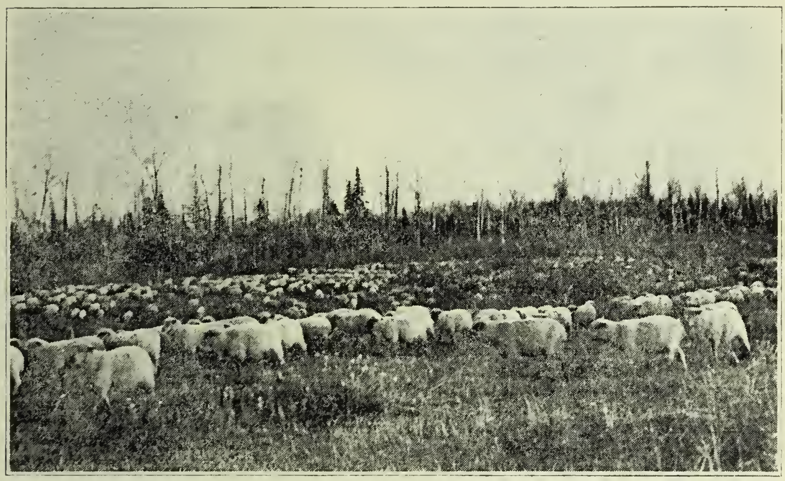


FIG. 13.—THE NATION NEEDS MORE WOOL

The settler needs more cleared land. Sheep on cutover land supply both needs.

FOCUS ON SWINE PRODUCTION

Special efforts were made this past year to focus attention on the matter of increased swine production. At the Farmers' Course in February this was made the dominant feature and through special educational exhibits and sales of purebred stock, the attention of farmers was specifically directed to pork production. Under the conditions in which we now find ourselves in this war, this matter is assuming a much greater importance, for the world's supply of fats is being greatly lessened.

LIVESTOCK EXCHANGE

The college has aided greatly in promoting the sale of much livestock both within and without the state. Through the development of the county agent movement and the boys' and girls' clubs in all part of the Union, much attention is being given to dairy cattle improvement. Scarcely a week passes in which committees of buyers are not visiting the College to locate car lots of dairy heifers and calves. These are going in constantly increasing numbers to the Mississippi Valley states and throughout the West. R. F. Murray (extension service) has spent much of his time this past year in bringing the prospective out-of-state buyer and the Wisconsin breeder together.

WISCONSIN DAIRY HERDS SELECTED FOR SERVICE

Eighty-one cow testing associations in which 40,000 cows are being "drafted for selective service" on 2,417 farms of the state, is Wisconsin's answer to the call for improved production. This work, supervised by H. C. Searles and Noel Negley, is carried on jointly by the animal husbandry department, the state dairymen's association and the dairy division of the United States Department of Agriculture.

In these days when the need of labor is so keen, it is of the utmost importance that each herd be brought to maximum efficiency. Thirty-seven new testing associations have been added this year to the 54 already in existence. The constant sifting process is teaching the dairy farmer to weed out the profitless cows. In the month of August alone 101 cows were rejected as "slackers." Five per cent of the entire list under test made a record of over 40 pounds of butterfat during this same month, an especially good record considering the fact that August is the low ebb of milk production.

In order to drive home the lesson most effectively, exhibits of the banner animals in the respective testing associations have been made at the state fair and at eight county fairs. These have been instrumental in attracting much interest among dairymen and will undoubtedly stimulate the organization of additional associations.

As the Holstein Friesian World recently said editorially:

> "The cow testers of Wisconsin have been doing a wonderful work during the past year and this work has been far more comprehensive than just merely testing the cows for butterfat production. It is truly interesting to note what the tester can accomplish when he undertakes to

> turn his efforts to the best purpose along all lines. Some have carried on campaigns of cleanliness all through the dairy barns in their association. Others have sought to make the farms more productive by analyzing the soil and returning what is most necessary.''

This work results directly in marked financial advantage to the herd owners. F. G. Swoboda, secretary of the Langlade association, says: ''I took a buyer out to see some grade Jerseys belonging to one of our members who has been in the association three years. The buyer got four cows at prices averaging $60 a head better than the member of the association would have been willing to take for them had these cows not been tested.''

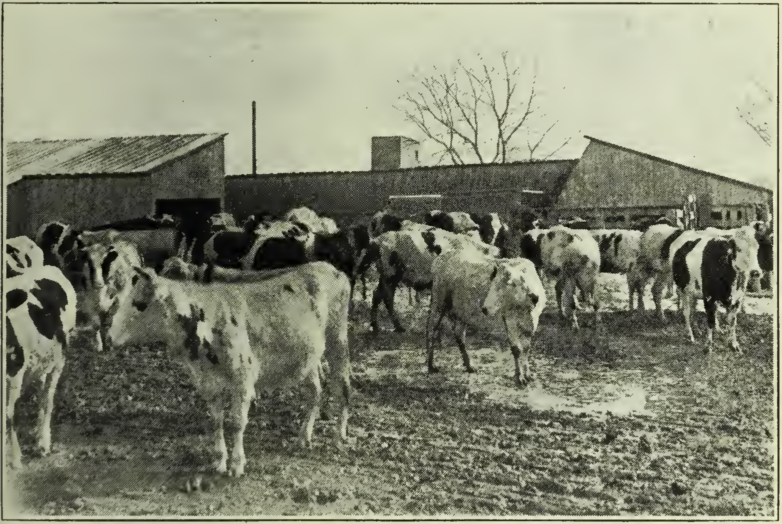


FIG. 17.—MOBILIZED FOR SELECTIVE SERVICE

Young Wisconsin cows which will be sent to the dairy front in the Southwest. These are part of a trainload.

Harvey Little of Janseville says, ''The cow testing association records of my herd increased the price I received for my bulls $100 a head.''

Not only is there this direct financial advantage, but the field testers are able to save the farmers many thousands of dollars through better rations and the cooperative purchase of feeds. One Association writes

> "We figure it saved $1,800 on our feed bill. During the early part of last summer 16 associations bought about 1,000 tons of feed. The fieldman reports 'Most of these purchases were made by giving the local dealer a small commission per ton for handling the order, the farmers paying cash and taking the feed from the car. In other cases the secretary or a committee on feeds handled the order direct'."

INOCULATION OF PEAS INCREASES PRODUCTION

A striking instance of increased production has been made this last season by E. B. Fred (bacteriology) who sent to the canning company of Holmen artificial cultures of bacteria for inoculating canning peas. Seed sufficient to inoculate about 100 acres was treated and planted on light sandy as well as heavy clay loams. A most striking difference was noted in the case of practically all fields grown on the lighter soils as is to be seen from figure 15. In nearly all cases peas grown on sandy soils were yellowish green in color and devoid of nodules on roots, and they produced one or two pods containing only 2 or 3 inferior sized peas, while the inoculated seed without exception grew vines of healthy dark green color, two feet or more in length, and produced 4 or 5 pods to the plant with 4 to 6 peas each. The root systems invariably had large nodular growths which furnished the necessary nitrogen to account for the difference.

On the heavier soils these striking differences did not exist as the uninoculated soil naturally contained the proper bacteria to induce nodule production.

On substantially all of the acreage planted on the lighter soil type, the increased yield produced by the inoculation alone was from four to ten-fold. So keen a demand has developed for cultures, that the bacteriology department has arranged to supply farmers this coming season with legume cultures at cost of preparation. This is a practical means of increasing production at practically no expense, not even for labor.

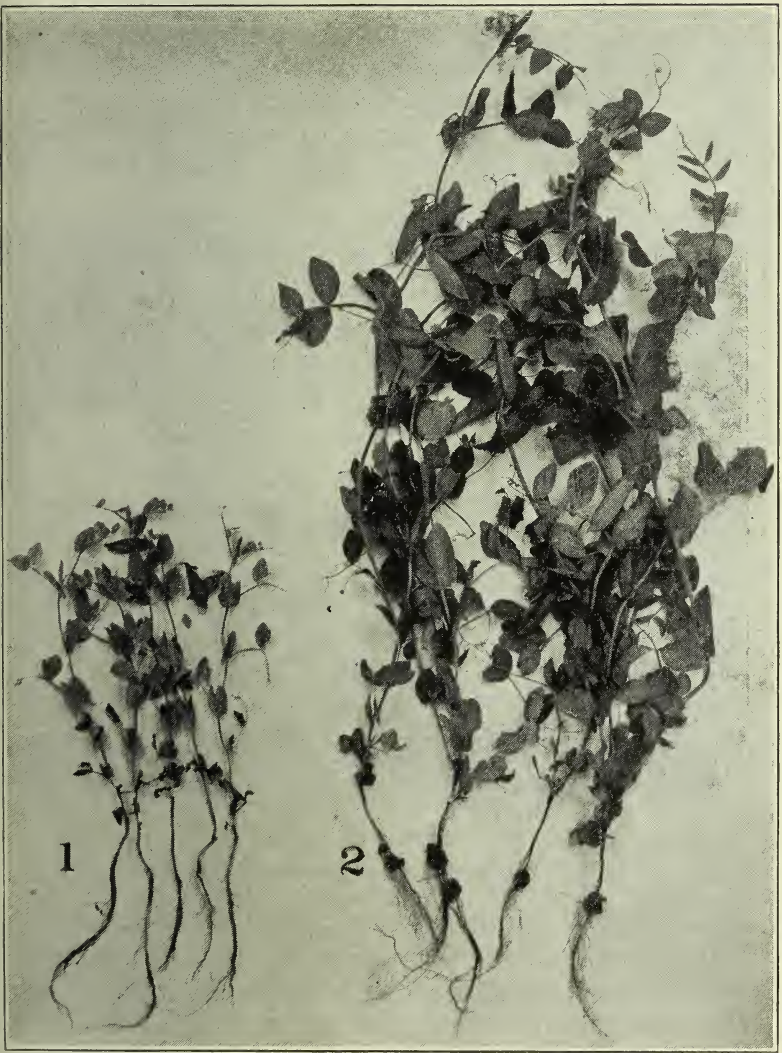


FIG. 15.—THE EFFECT OF INOCULATION ON FIELD PEAS

1. Uninoculated. 2. Inoculated.

MILLERS AND BANKERS COOPERATE WITH COLLEGE IN BREAD DRIVE

On July 20 the Wisconsin Millers' association held its annual meeting at Neenah. The millers devoted a considerable part of their program to discussions relative to food production and food supply and to related agricultural interests. They are vitally interested in the production of wheat and rye and they had R. A. Moore (agronomy) discuss with them the various ways in which they could aid in encouraging larger and more economical production of bread crops. One item of publicity suggested to the millers was the placing at their local county fairs of exhibits calling attention to the food situation in general, to the necessity and advantages of increased production of flour crops, and to the various means helpful in securing this increase. This suggestion was put in concrete form by such an exhibit placed by the Agricultural College in the assembly hall where the meeting was held.

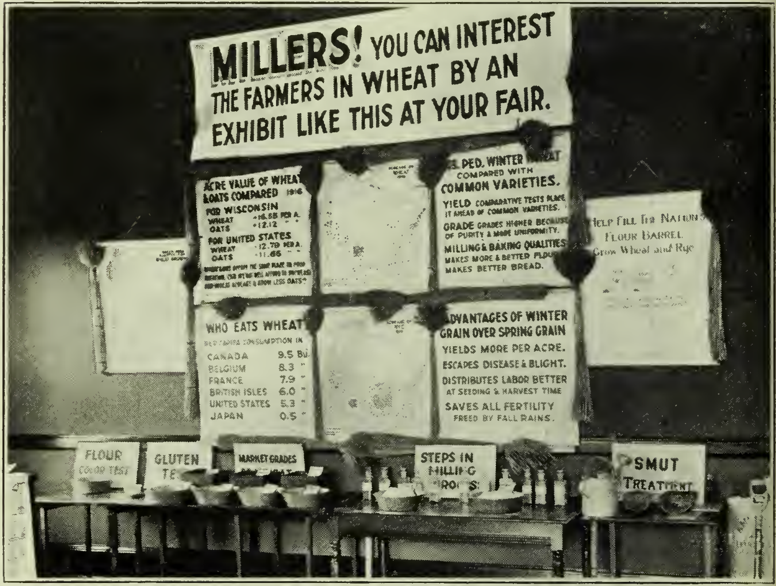

MILLERS! YOU CAN INTEREST THE FARMERS IN WHEAT BY AN EXHIBIT LIKE THIS AT YOUR FAIR.
ACRE VALUE OF WHEAT & OATS COMPARED 1916
FOR WISCONSIN
WHEAT +16.58 PER A.
OATS +12.12
FOR UNITED STATES
WHEAT +12.79 PER A.
OATS +11.66
PED. WINTER WHEAT COMPARED WITH COMMON VARIETIES.
YIELD COMPARATIVE TESTS PLACE IT AHEAD OF COMMON VARIETIES.
GRADE GRADES HIGHER BECAUSE OF PURITY & MORE UNIFORMITY.
MILLING & BAKING QUALITIES MAKES MORE & BETTER FLOUR MAKES BETTER BREAD.
HELP FILL THE NATION'S FLOUR BARREL
Grow Wheat and Rye
WHO EATS WHEAT
PER CAPITA CONSUMPTION IN
CANADA 9.5 Bu.
BELGIUM 8.3
FRANCE 7.9
BRITISH ISLES 6.0
UNITED STATES 5.3
JAPAN 0.5
ADVANTAGES OF WINTER GRAIN OVER SPRING GRAIN
YIELDS MORE PER ACRE.
ESCAPES DISEASE & BLIGHT.
DISTRIBUTES LABOR BETTER AT SEEDING & HARVEST TIME
SAVES ALL FERTILITY FREED BY FALL RAINS.
FLOUR COLOR TEST
GLUTEN TEST
MARKET GRADES
STEPS IN MILLING PROCESS
SMUT TREATMENT

FIG. 16.—HOW THE MILLERS COOPERATED WITH THE COLLEGE

The drive for more wheat resulted in a greatly increased acreage.

As a result of this suggestion the Wisconsin Millers' association provided a similar but more complete exhibit which was displayed by local millers at the fairs in Lincoln, Marathon, Portage, and Dunn counties. Keen interest in this exhibit gave the millers opportunity to use their influence in securing an increased acreage in flour-producing crops.

BANKERS LEAD IN PEDIGREE WHEAT DISTRIBUTION

About four years ago the agronomy department began distributing from the Experiment Station farms two pedigreed varieties of winter wheat. In tests covering a period of years these pedigree wheats had yielded on the station farms an average of more than thirty-five bushels an acre, while the yield and quality of flour proved to be considerably above that of other wheats with which they have been compared in milling and baking tests.

As a means of increasing the wheat production of the state, the growing of the high yielding varieties is a most important factor. While the acreage which can be profitably planted to wheat is limited by the demands of other important and necessary crops, increased production is still possible from higher yields due to the use of purebred seed. This affords another solution of the bread problem.

This fall the necessity for a larger wheat production made it imperative that we not only increase the acreage of winter wheat, but that only the very highest grade and most productive seed be used. In taking stock of the supply of pedigree wheat available for seed purposes, about 4,000 bushels were located, distributed amang fewer than 60 growers. In order to multiply this purebred wheat as rapidly as possible, the Wisconsin Bankers' association offered to distribute it through their local bankers, who used their personal acquaintance with the farmer patrons to insure that the seed got into the hands of careful farmers who would keep it pure and agree to save next year's crop for seed purposes.

This movement resulted in getting into the ground the entire available supply of pedigree wheat. It will be grown for distribution to farmers as seed for next year's crop.

"THE PURE SEED AND HOME POWER SPECIAL"

The "Special," run jointly by the "Soo Line," the C., M. & St. P. R. R. the Wisconsin Bankers' association, and the Wisconsin College of Agriculture, was the agency used by these institutions to bring home to the people of the state two timely and important messages.

The Pure Seed Car contained a display of the finest Wisconsin grown seed grains, reinforced by legends and explanations emphasizing the advantages of planting only purebred and high-testing seeds on our farms. Special emphasis was laid on the emergency crops such as beans, and the sandy land crops which can bring into productivity many acres of uncultivated land. Our hope for these crops is that in this time of world-wide food shortage they will be the means of augmenting our productive capacity to a greater extent than increased yield alone on already productive land can accomplish.

The Home Power and Home Convenience car demonstrated that the dream of the farmer's wife of yesterday is the reality of today. No longer need the duties of homekeeping on the farm be turned into drudgery and discomfort by the carrying of tons of water, by the back-breaking tasks over wash board and churn, and the lack of facilities for lighting, bathing, and sewage disposal. The gasoline engine, the power churn, the washing machine, the separator, the home light plant, simple yet effective systems for hot and cold running water in the house, and the septic tank system for sewage disposal, are all within reach of the individual farm home. This was demonstrated by lectures and observation of the running machinery and models in the Home Convenience Car. Twenty-seven stops in 16 counties were made and lectures and demonstrations given which were visited by 7,000 persons, enthusiastic in their appreciation of the gospel of better farming and better homes.

DAIRY DEMONSTRATIONS CONTROL FACTORY LOSSES

The work of the dairy department in the control of factory losses has been continued by G. H. Benkendorf. Through local conferences with creamery and cheese factory managers and patrons, new accounting systems have been introduced for the purpose of checking losses, fuel wastes have been eliminated, and septic tanks and sewage disposal systems have been intalled.

In one instance (the Foley cheese factory at South Wayne) an annual loss of over $4,000 was detected and prevented. Much difficulty was experienced from gassy fermentation in cheese which was traced by J. L. Sammis to the whey tank from which it was transferred to the farmers' milk cans, thus contaminating the whole milk used in cheese manufacture. After the installation, at a small cost, of an apparatus for pasteurizing the whey, this trouble entirely disappeared.

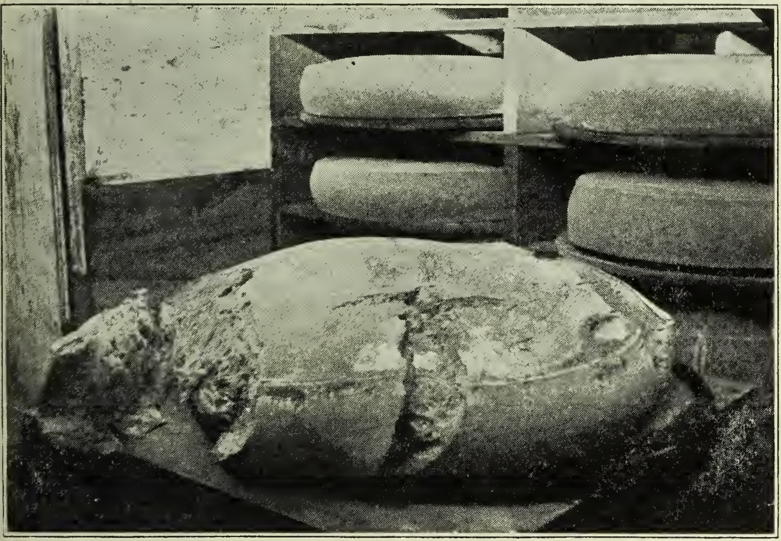


FIG. 17.—REDUCE FACTORY LOSSES

Gassy fermentation causes large losses in the cheese business. By proper treatment perfect cheese like those on the shelves will always be made.

FARMERS INTERESTED IN KEEPING ACCOUNTS

Never before have farmers shown such active interest in the cost of production of food products as has been evidenced this year. In an effort to get at the factors in the cost of production they have taken keen interest in the keeping of farm accounts, the work being under the general direction of D. H. Otis (agricultural economics).

An illustration of this interest is shown in the growth of the North Lake farm management club whose activities are being copied by other clubs organized on the same plan in other sections of the state.

Each farmer paid a membership fee of $2 to cover necessary local expenses in conducting the work and 90 per cent of the farmers enrolled kept a complete set of accounts throughout the year. By following this plan in other localities, between 400 and 500 farmers have been encouraged in keeping financial records during the past year.

FIG. 18.—FARMERS WHO KEEP BOOKS

A group of the members of a farmers' club at North Lake, Wisconsin

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Wisconsin Bulletin 295 August, 1918

Getting Rid of the Stumps

AGRICULTURAL ENGINEERING DEPARTMENT

FROM VIRGIN FOREST TO FERTILE FIELD

Modern methods and improved machinery make the clearing of land much easier.

AGRICULTURAL EXPERIMENT STATION
OF THE UNIVERSITY OF WISCONSIN

MADISON

DIGEST

Brush, logs, and stumps keep 10,000,000 acres of upper Wisconsin from cultivation. Reclaimed from the jungle of rubbish on the surface, the soil will feed millions of people. Wheat is a staple crop. Stock raising is profitable and helps to clear the land. Pages 3–4.

The jungle gets thicker with each year unless stopped by burning, cutting, or pasturing. Grass seeding is a factor. Brushing kills the hardwood stumps and they decay in a few years. Plowing between the remaining stumps may be a good practice for the settler getting a foothold, but the reclamation is not complete until the last pine stump is removed. Page 5.

Explosives and stump pulling machines get the stumps out of the ground. Many communities have peculiar devices of their own. Of the standard types, capstan stump pullers are probably more common, although many of the upright or tripod pullers are in use. For both of these, horses supply the power. Horses on a block and line, man power machines, and a few large machines with drums driven by an engine are also used. The hooks and chokers for gripping a stump or root form an important part of the equipment. Both men and teams get more efficient with experience. Pages 6–17.

Piling machines save man power in getting rid of the stumps. Large stumps pulled whole have to be split with dynamite and old logs have to be sawed to make piling and burning easier. Cleaning the earth from the roots is sometimes a difficult task in clay soils. The earth belongs back in the stump hole. Cradle knolls, leveled, make breaking easier and drainage better. Pages 18–19.

Figures on cost of stumping show that the stump and not the acre is the unit of measure. The cost varies with the kind and condition of the stump, the number of stumps, the type of soil, and the skill of the workman. Pages 20–22.

Studies and demonstrations in cooperation with railroads and manufacturers of stumping equipment have been made by the College of Agriculture. A special train carried the equipment for demonstrations in fifteen places in 1917. Similar demonstrations were made in 1916. Pages 22–27.

Improvements in methods have resulted from the studies and demonstrations. Lower grades of dynamite, which are cheaper, have been found in certain cases to be better than the higher and more expensive grades. The Conrath piler has been operated where only a gin pole was ever seen before. The piler itself has been improved by the Frost trip. Improvements in the take-ups, cluster cables, and the root hooks have followed. The spirit of cooperation fostered by the demonstrations has made neighbors cooperate in the purchase of machinery and in the exchange of help to lower the cost of stumping. Pages 27–28.

Studies are in progress on methods of preparing lands for stumping: the proper grade and amount of dynamite to use, the most economical size of crew, the comparative advantage of stumping by contract and by cooperation between neighbors, the standardization of methods, pulling before cracking or pulling after cracking, and a reliable basis for estimating the cost of stumping. Pages 29–32.

Getting Rid of the Stumps

AGRICULTURAL ENGINEERING DEPARTMENT*

Stump removal has been a problem in practically all parts of Wisconsin. The stumps in southern Wisconsin were removed in pioneer days by back breaking labor. The work was done largely by hand. Today the problem of land clearing is limited largely to upper Wisconsin. Modern methods and machinery make the work easier.

THE CUT-OVER LANDS

About 10,000,000 acres of cut-over lands in upper Wisconsin are in the twilight between the lumberman's paradise and the farmer's estate. Beneath the jungle of fallen logs, stumps, and tree tops, is a soil that bids fair to do more for humanity by raising wheat for food than it did raising logs for lumber.

Start the clearing where clearing is easiest. Irregular fields are pardonable if they follow the lines of easy clearing and good land. In pioneer days it is cleared acres that count. The sides of the fields should be straightened later, but not at the expense of productive area.

Brushing and stumping are the two steps in land clearing. Brushing consists of cutting the brush and straggling trees and piling them for burning. Complete brushing includes also the piling and burning of the down logs small enough to be piled by hand. Stumping gets the stumps out of the ground and out of the way. It includes the piling and burning of the remaining down logs, too large for hand piling.

Cutting the sprouts in August after brushing kills the roots and makes the brushing permanent. Grass seeding makes the brushed land profitable. Pasturing or haying between the stumps paves the way for dairying. In the meantime, the

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* Compiled by F. M. White and E. R. Jones from notes by Carl Livingston, L. F. Livingston, Alfred Mathewson and Joseph Hussey.

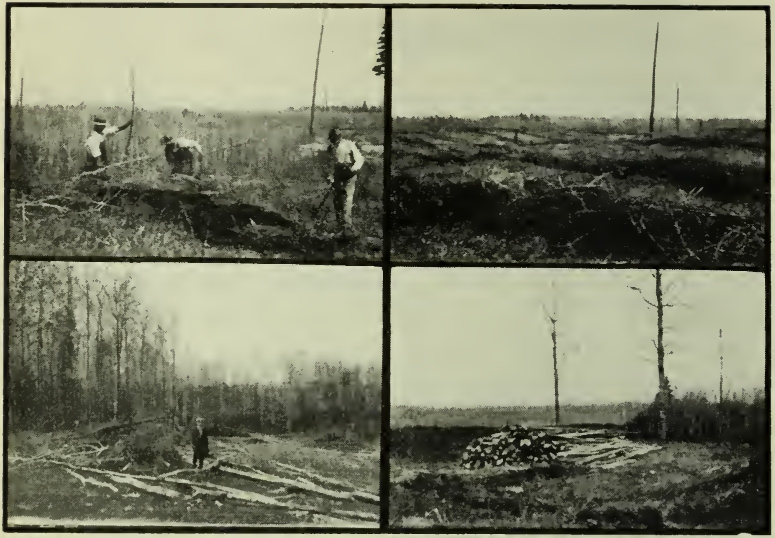

FIG. 1.—BRUSH PILED IN WINDROWS

This light poplar brush has been piled in windrows. It is sometimes better practice to pile the brush in larger piles. In brushing, the wood which may be saved (see lower right-hand illustration) helps pay the cost.

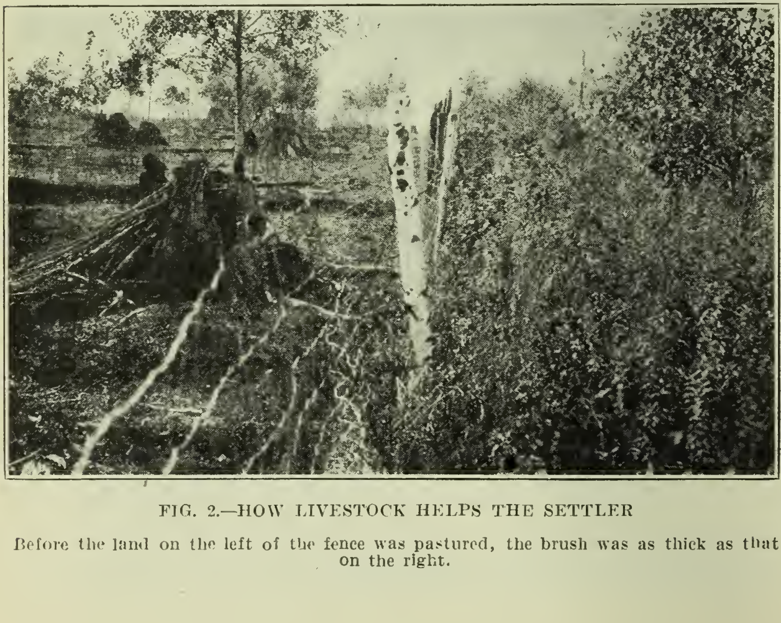

FIG. 2.—HOW LIVESTOCK HELPS THE SETTLER

Before the land on the left of the fence was pastured, the brush was as thick as that on the right.

condition of the land improves. The fibrous roots of the stumps decay. This adds humus to soil and makes the removal of the stumps easier after three or four years.

Plowing between the stumps for cultivated crops is sometimes all right, but the practice is wasteful in the long run. The stumps interfere with the cultivated crops more than they do with grass. A big pine stump may prevent plowing and cropping two square rods of land. Hardwood stumps make up in number what they lack in size. It is easier to harvest a whole crop of grain on a clean acre than two-thirds of a crop on a stumpy acre.

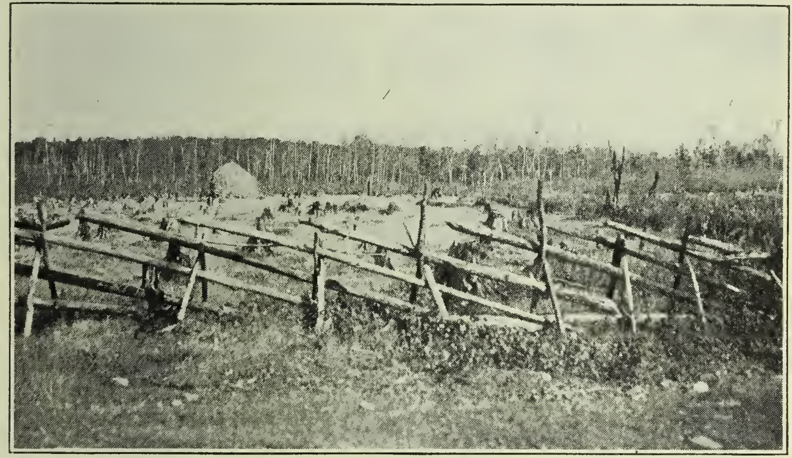

FIG. 3.—HAY BETWEEN THE STUMPS

Hay is a profitable crop to grow between the stumps. A steady team can mow this with a mower.

It is more pardonable to dodge the hardwood stumps than the pine in a cultivated field. Each year after brushing makes the removal of the hardwood stumps decidedly easier. The effect of time on the pine stumps is not so noticeable.

Methods of Stumping

The stump puller and dynamite working hand in hand offer the solution of the stump problem. It is seldom advisable to use either alone. A proper combination of the two methods is more economical.

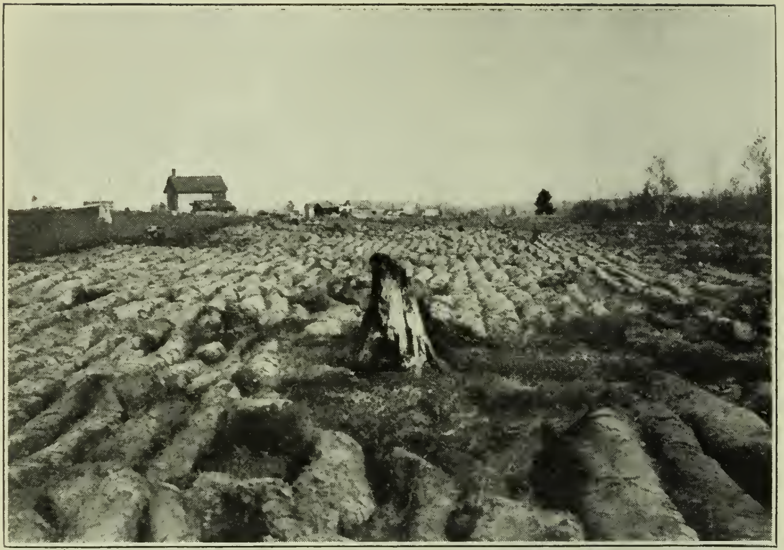

FIG. 4.—THE STUMP THAT STOPPED THE PLOW

A pine stump may waste two square rods of a field. Dodging a stump is poor practice.

FIG. 5.—READY FOR THE HARVESTER

Stumps are a nuisance in a field like this. Every stump wastes wheat.

Dynamite in Stump Removal

Investigational work has made it possible to separate the uses of dynamite for stump removal. Under general conditions the amount of dynamite required in each method decreases in the order in which they are listed:

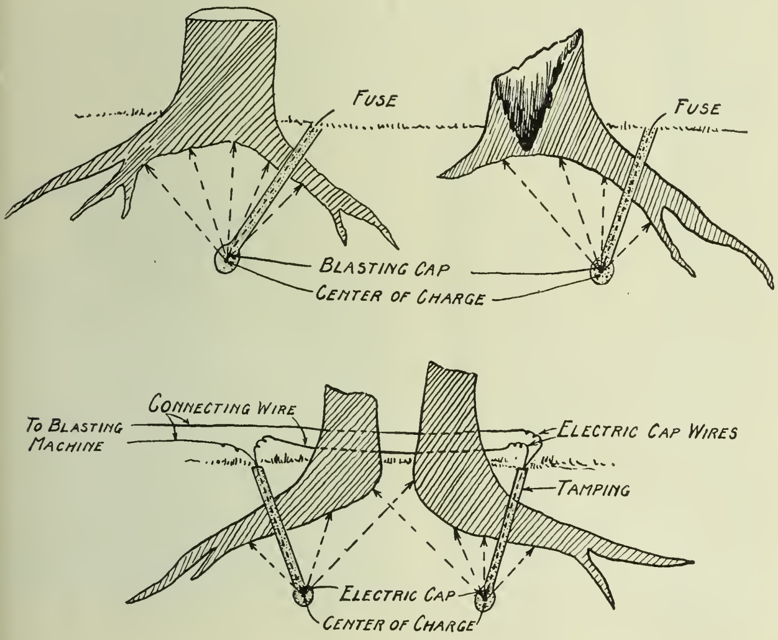

FIG. 6.—PLACING THE CHARGE

Upper left: cap and fuse method of loading under a solid, firm, evenly rooted stump. Upper right: top-rotted or hollow stump with roots rotted away on one side. Lower: separated roots of a top-rotted stump. Dotted lines show the direction of the explosive force. Electric cap could be used in each case.

1. Blowing out the stump completely.
2. Cracking the stump to pull it with a team on a straight line.
3. Cracking the stump to pull it with a "block and line."
4. Cracking the stump to pull it with a stump puller.
5. Cracking the stump after it is pulled with a stump puller.

Regardless of purpose, success depends on the proper handling and use of the explosives.

To blow out a stump completely, the stump, the soil, the tools, and the explosives must be considered. It is first necessary to know the stump—its kind, age, and condition; the soil—its character and moisture content; the best tools and their use; and the lowest priced dynamite that will do effective work.

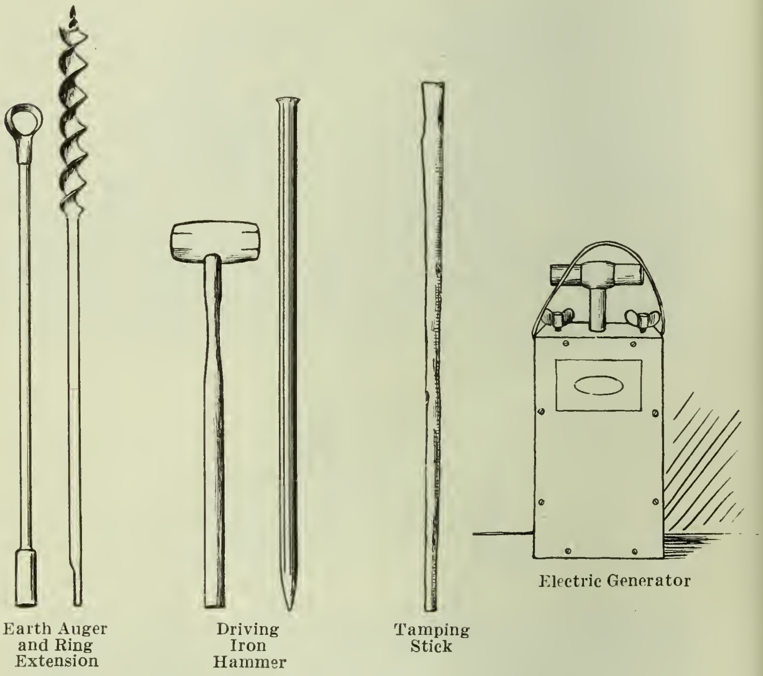

FIG. 7.—BLASTING TOOLS SIMPLE AND SAFE

These tools are simple but effective. The electric method of detonation has many advantages over the cap and fuse method. The downward stroke of the plunger generates a current of electricity that explodes the electric cap.

The most economical results in stump blasting are obtained with a firm, dead, lateral rooted stump in moist clay, with all the fibrous and smaller roots decayed. A charge of 20 per cent dynamite, properly placed and thoroughly tamped under such a stump, will throw it out in pieces which can be handled easily and burned. As the character of the stump and soil change, methods and tools vary.

Methods of Loading and Firing. A charge of dynamite placed under a stump to blow it completely out of the ground should be located where the stump is tightest. This location is not necessarily under the center of the stump.

A single charge properly placed so that the force of the explosion will be applied where the stump is tightest is to be recommended for stumps not too large, and without widely spread lateral roots, or when the smaller top-rotted stumps have their lateral roots joined at the crown. The firing can be done with an ordinary No. 6 cap or a No. 6 electric cap.

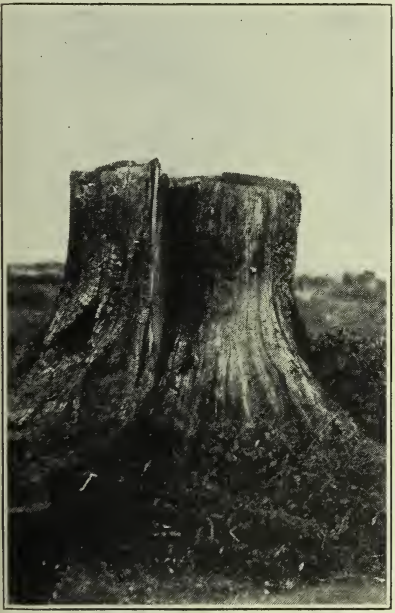

FIG. 8.—GOODBYE TO AN OLD SETTLER

Cracked into four pieces by two pounds of dynamite placed exactly right. It is all ready for the puller.

The electric method of firing is recommended generally because it is quicker and safer. It is especially recommended for large stumps or blind stumps (top-rotted) because it permits firing at the same time the several charges distributed around the stump.

Tools. A 4-foot driving iron made of 1½ inch octagonal (eight-sided) tool steel and an 8- or 10-pound double-faced hammer are the best all around tools for making holes under stumps. They save time and will make a hole in practically all soils. The iron is easily pulled out of the ground by battering it on the sides a few times. If it should stick, a pole or a bar slipped through a short piece of chain half hitched around the iron will easily pry it out.

For holes deeper than four feet the earth auger is best.

Proper loading of dynamite in bore holes is of vast importance. The paper cartridges should be slit with a sharp knife **from end to end three or four times,** then dropped to the bottom of the hole and crushed by firmly pressing with a **wooden** tamping stick. The cartridge containing the cap should not be slit at the primed end.

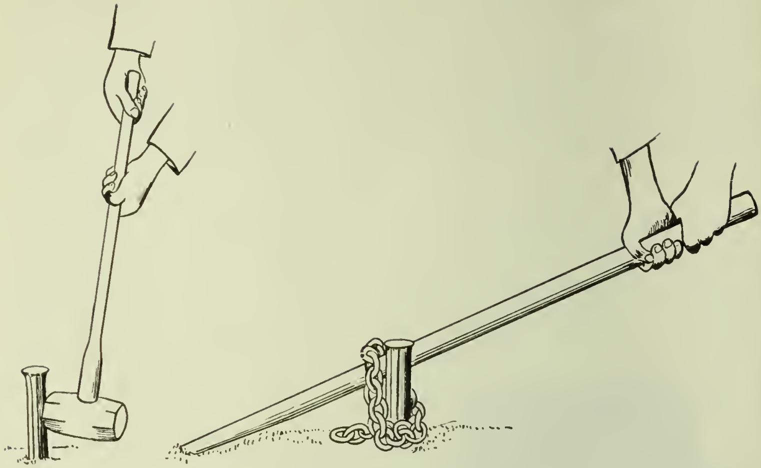

FIG. 9.—LOOSENING THE DRIVING IRON

A few taps with a hammer make the hole larger and let the driving iron come out easily. It is sometimes necessary to use a chain and bar to pull the iron (shown at the right).

Tamping or confining the loaded charge is the biggest single factor in the success of stump blasting. Improper and careless tamping wastes dynamite, time, and money. Damp clay is the best material for tamping, but any soil used should be firmly tamped and made as firm as the surrounding soil. All pressure from the explosion escaping through an improperly tamped bore hole is wasted. About four inches of earth should be firmly pressed on top of the charge. Crumbled soil (not lumps) should then be rammed tightly with a **wooden** tamping stick all the way to the top of the hole.

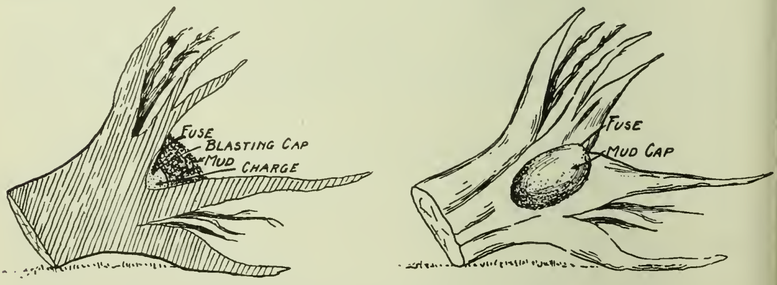

FIG. 10.—SPLITTING WITH DYNAMITE AFTER PULLING

At the left is shown the placing of the charge in the butt of the stump—at the right, in a crotch at the side. Plenty of mud can be used for a cap. Electric blasting cap may be used instead of the cap and fuse.

The amount of dynamite required depends on several factors: the size, age, kind and condition of the stump, and the character and moisture of the soil. Table 1 shows the amounts of dynamite used to blow out completely white pine stumps under the conditions given.

TABLE I.—USE THE RIGHT AMOUNT OF DYNAMITE: THE AMOUNTS GIVEN IN THIS TABLE DID GOOD WORK.

At Haugen 40 years old 20 per cent dynamite Silt Loam Soil		At Washburn 30 years old 20 per cent dynamite Superior Red Clay		At Holcombe 27 years old 40 per cent dynamite Sandy Loam	
Diameter inches	Load pounds	Diameter inches	Load pounds	Diameter inches	Load pounds
15	1	10	¾	13	1½
24	4	14	1	14	1½
24	4	14	¾	15	2
26	5	16	1	15	2½
26	3½	16	1	15	1½
27	4	16	1¼	18	2
28	4½	18	1	20	3
28	2½	20	1	20	4
30	2½	20	1½	21	4
30	2	22	2	21	4½
34	4	22	1½	24	4½
34	4½	26	1½	24	5
36	5	28	2	24	5
40	7	28	1¾	27	5½
40	6½	30	1½		
44	4½	30	2		
45	6½	30	1		
45	3	30	2½		
		30	4		
		33	3		

Cracking before or after pulling. To crack for a team pull, dynamite should be loaded in exactly the same manner it would be if intended to blow out the stump completely, and the charge should be reduced from three-quarters to two-thirds. To crack for a "block and line" the loading is done in the same way and the charge reduced about one-half. To crack before pulling with a stump puller, the loading is done in the same way and the charge reduced to approximately one-third to one-quarter as much as for complete removal; to crack after pulling, the charge should be reduced to about one-fifth to one-sixth as much and should be loaded in either a natural crotch between the roots at the side of the stump or in the butt close to the crown. It is not necessary to bore in the wood. The dynamite should be placed close against the wood and thoroughly covered with plenty of mud.

Grades of dynamite. It is rarely necessary to use a dynamite quicker than a 20 per cent grade. Except in loose sandy soil, 20 per cent dynamite will give exactly the same results as 40 per cent and 60 per cent, using pound for pound.

STUMP PULLERS

Capstan pullers. Most of the horse power stump pullers on the market make use of a vertical drum. A sweep from 12 to 22 feet long forms the capstan bar. One end of a wire cable winds on the drum and the other end is attached to the stump. It is called the pull line. Ordinarily the power of the team is multiplied by 25 or 30, but by the use of power pulleys the pulling power is multiplied indefinitely.

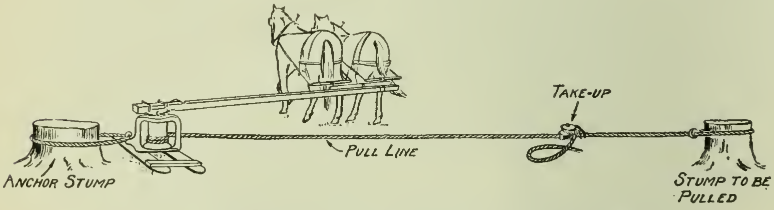

FIG. 11.—CAPSTAN PULLERS NEED PLENTY OF LINE

The hitch is low on the anchor and high on the stump to be pulled, to prevent the anchor from starting first. At least 150 feet of pull line is needed and the take-up is put on wherever it is needed.

The smaller the drum the greater the power with the same length of sweep, but the harder it is on the cable because of the sharpness of the bend. A drum is full when it has a single layer wound on it from bottom to top. This is usually from 10 to 15 rounds or from 30 to 60 feet of cable. To wind more than one layer on the drum cuts the cable.

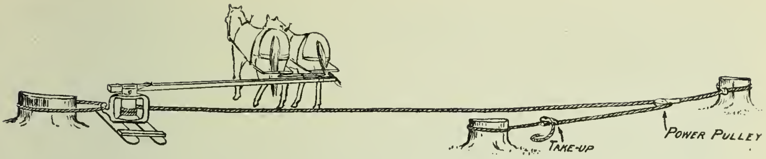

FIG. 12.—POWER PULLEY IN ACTION

The power pulley multiplies the power of the capstan puller by two.

To pull stumps near the puller with a pull line 150 feet long and a drum that holds only 50 feet, a take-up attached to the line at the desired point gives the desired length of line. A 150-foot pull line is an advantage because a bigger area can be stumped for a single anchor. An extension of 75 feet on a 150-foot line is common. The anchor cable is sometimes extended to increase the radius of the machine or to get a better place for it to work. A solid stump must be used for an anchor because it must be stronger than the stump to be pulled.

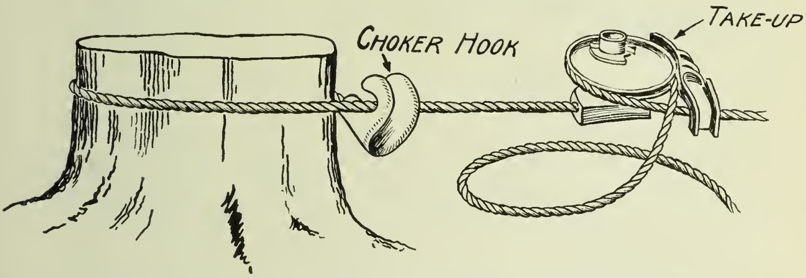

FIG. 13.—CHOKER AND TAKE-UP MAKE PULLING SIMPLER

The cable is placed so that there is no bend at the choker hook. The take-up may be put anywhere on the pull line. It is well to have 150 feet of cable and to take up slack with this take-up. This is a cam take-up. Some other types are equally satisfactory.

The cable is attached to the stump with a solid top by means of a choker. A cluster of three cables makes it possible for the men to put a choker on a second or a third stump while the first one is being pulled. Where the stumps are small the three stumps may be pulled at the same time. Stumps with decayed tops can be gripped only by a root hook.

The smallest crew to use with a stump puller is three men, one to drive the team and two men to handle the chokers or the hook. Two extra men, one to help the driver operate the machine and the other to handle one of the chokers or to prepare stumps for the hook, make progress somewhat faster, but the practice is questionable.

Good stump pullers are so made (1) that they are light and strong, and easily movable from place to place; (2) that they lock automatically against the back lash of the sweep in case something breaks; and (3) that they have a drum release to relieve the horses of pulling while crossing the cable. It is convenient but not necessary to have the machine equipped with a truck.

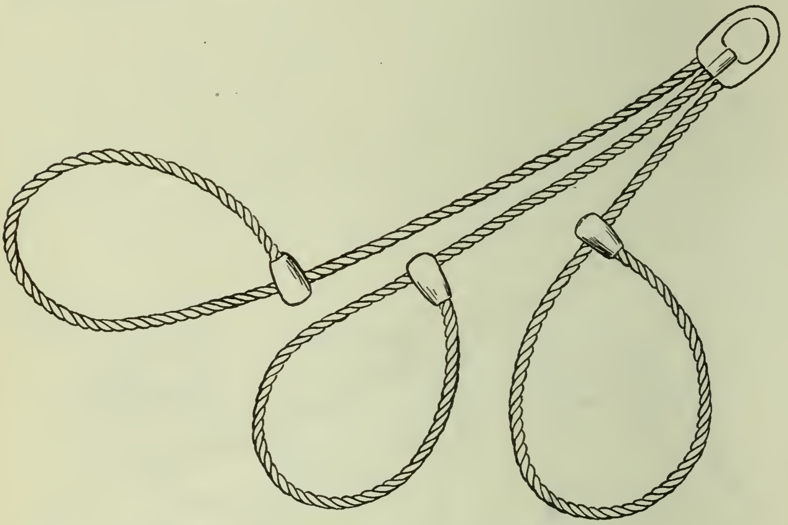

FIG. 14.—CLUSTER CABLES SPEED STUMPING

This cluster of three chokers is fastened on the pull line. Two or three small stumps may be pulled at once.

Here is the equipment needed for a capstan stump puller:

150 feet of ⅞″ cable
75 feet of ⅞″ cable for extension
32 feet of ⅞″ anchor cable
22 feet of 1⅛″ cable for extending anchor
2 power pulleys
3 automatic take-ups (with choker on each)
1 root hook
1 cluster of three chokers

The individual farmer buying a stump puller for use on his own farm might omit the extension cables, one power pulley, one take-up and the cluster cables. For the more powerful machines the diameter of the cable increases.

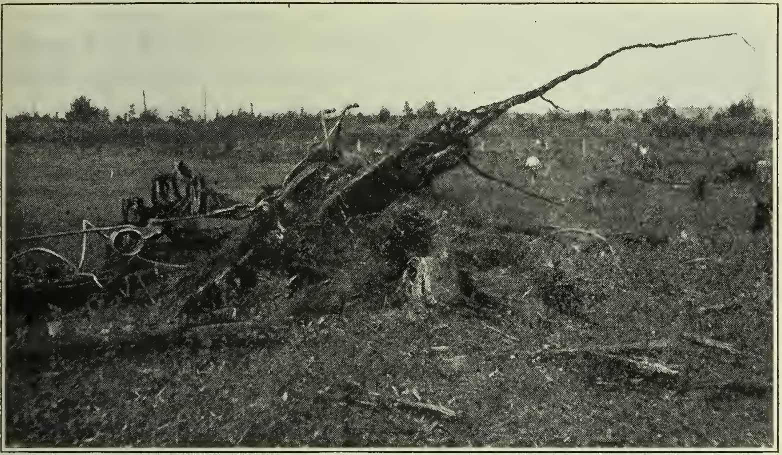

FIG. 15.—A ROOT HOOK FOR PULLING ROTTEN TOPPED STUMPS

A root hook weighs from 50 to 150 pounds. When the choker breaks off the top of a stump, or when the stump is top-rotted, this hook is used on the roots.

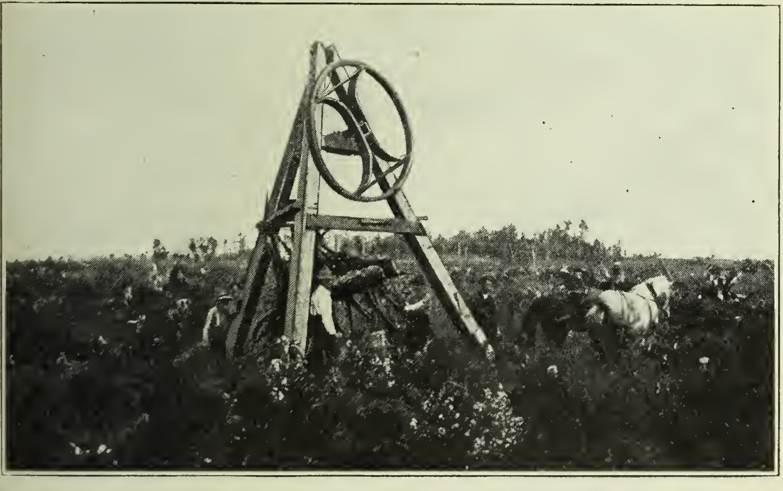

FIG. 16.—A VERTICAL LIFT STUMP PULLER

Where stumps are large and scattered the tripod puller is an efficient machine.

Tripod puller. The tripod puller has been very popular in many cases, particularly where the roots are shallow and spread near the surface of the ground. It has plenty of power and does not require much cable, but has the disadvantage of requiring moving for every stump. The machine costs from $175 to $250.

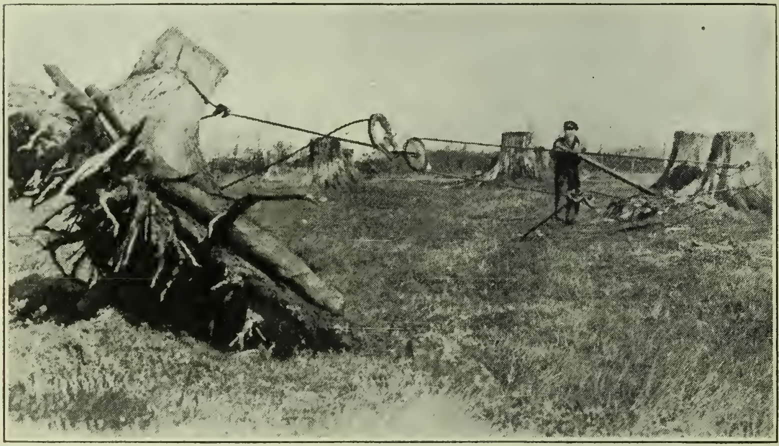

FIG. 17.—ONE-MAN STUMP PULLER

A machine for multiplying the pulling power of a man.

One-man puller. The one-man stump puller develops a great pulling force at the sacrifice of speed. The machine is easily transported from place to place and can be used conveniently in marshy places where a team could not operate. It costs from $50 to $200.

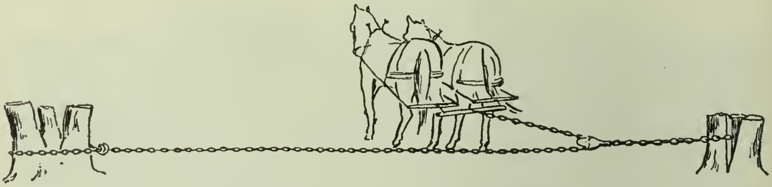

FIG. 18.—SINGLE BLOCK AND LINE

A convenient method of doubling the strength of a team. For greatest efficiency the team should pull toward the anchor instead of at an angle.

The block and line. A simple pulley attached to the stump or snag to be pulled gives a team on a chain double power where the other end of the chain is anchored to another stump or snag. A ⅜-inch chain is commonly used. This seems to be the simplest power team-hitch on a stump too strong for a straight pull. It is commonly called the "block and line" method but should not be confused with the more complicated block and tackle which is too intricate for general practice. The accompanying diagram shows how, by adding another pulley, the power of the team can be multiplied by four.

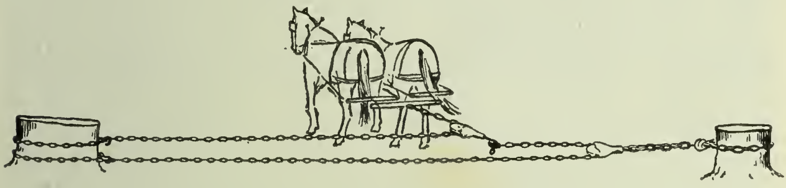

FIG. 19.—DOUBLE BLOCK AND LINE

This multiplies the power of the team by four.

The engine and drum. Drums run by an engine have not yet been perfected for stump pulling. There are machines on the market which may prove satisfactory with improvements. Generally these machines are not geared low enough to give a pull of sufficient strength to be of practical value. For efficient work, any power machine should have a haul-back line to haul back the main line after the stump has been pulled.

Piling and Burning

It is possible to pull large pine stumps whole but in clay soils a great deal of earth clings to the roots. This leaves a large hole. The earth must be removed from the roots either by hand or blasting after pulling. Stumps shattered by dynamite before pulling are pulled in separate pieces and less earth sticks to the roots than when pulled whole. Furthermore, the stumps split in pieces are ready for piling and burning.

The stumps may be used for fuel but they are usually piled and burned on the ground. In either case the earth must be removed from the roots. It belongs back in the stump hole.

The high narrow pile burns better than one more spread out. The gin pole with a team, line and pulley is a simple, helpful device. Even with careful piling the stumps must be repiled to burn completely. Logs and stumps burn best when piled separately.

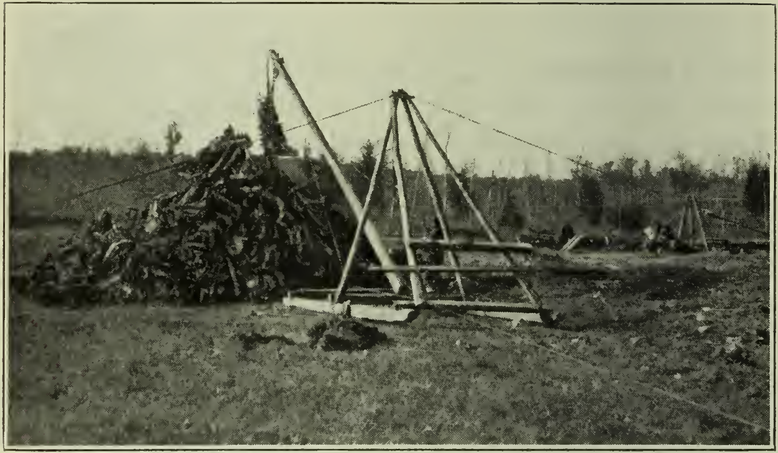

FIG. 20.—THE CONRATH PILER—AN UPPER WISCONSIN STANDBY

A homemade piler. The irons can be made by a blacksmith and cable purchased for about $60. It will pile either stumps or logs.

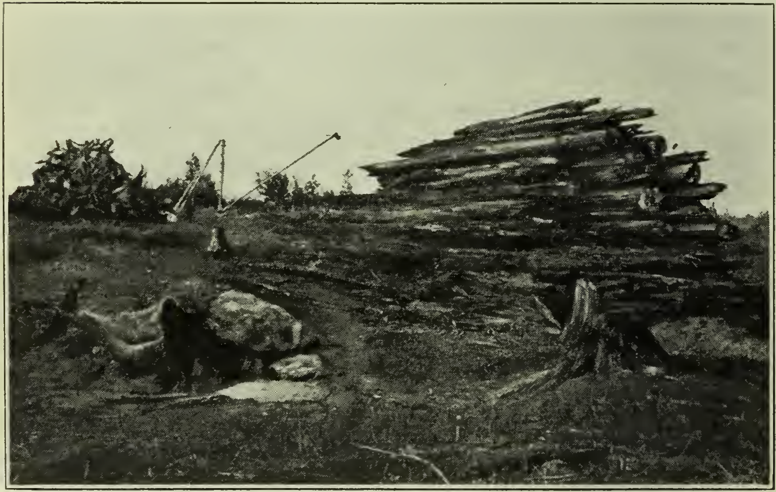

FIG. 21.—HOW TO PILE LOGS FOR BURNING

Lay the logs parallel. Make the pile high by means of a piler. Pile logs and stumps separately. Each keeps the other from forming a compact pile.

Movable pilers of various types are in use. Of these the Conrath piler has probably met with the most approval. Blue prints of this homemade machine (Fig. 20) can be secured from the College of Agriculture. The iron parts can be purchased from stump puller manufacturers or made by blacksmiths for about $60. This includes 150 feet of half-inch and 100 feet of 3/8 inch cable. The farmer himself can cut the timbers for the piler. The swinging boom is about 30 feet long with a sheave at the end of it. From this sheave is suspended a single block to give a team double power in lifting the stump to the end of the boom. The pull of the horses then swings the boom until the stump is over the pile when it is dropped. A team or one good horse can usually lift the stumps as fast as two teams can drag them to the piler. Small pieces of stumps may be hauled on a stone boat and thrown on the pile by hand. For the smaller hardwood stumps a piler is less essential than for the larger pine stumps.

Dropping stumps on the burning pile keeps it stirred up and aids the burning. For this practice a particularly long boom is necessary. Even then, it is too hot for men to work with comfort near the burning pile and a sudden change in the direction of the wind places the piler in danger of burning.

The trip for dropping the stump at the right time is an important part of the piler. Such a trip is shown in Figure 22. It can be made by a blacksmith or a similar one can be purchased from a stump puller company for about $5. A hook has been provided at the end of the cable to drop the stump by releasing the horses when the trip refuses to work.

The Conrath piler and the Frost trip, taking their names from the farmers near Ladysmith who designed and made them for their own use, are good examples of the devices that have been worked out by farmers themselves and popularized by the College of Agriculture and other organizations for the improvement of land clearing methods. When Frank and Charles Conrath got tired of piling by hand and later tired of the gin pole they built their first piler with a swinging boom. Mr. Frost, a neighbor, perfected the piler with his trip. Neither of these devices has been patented.

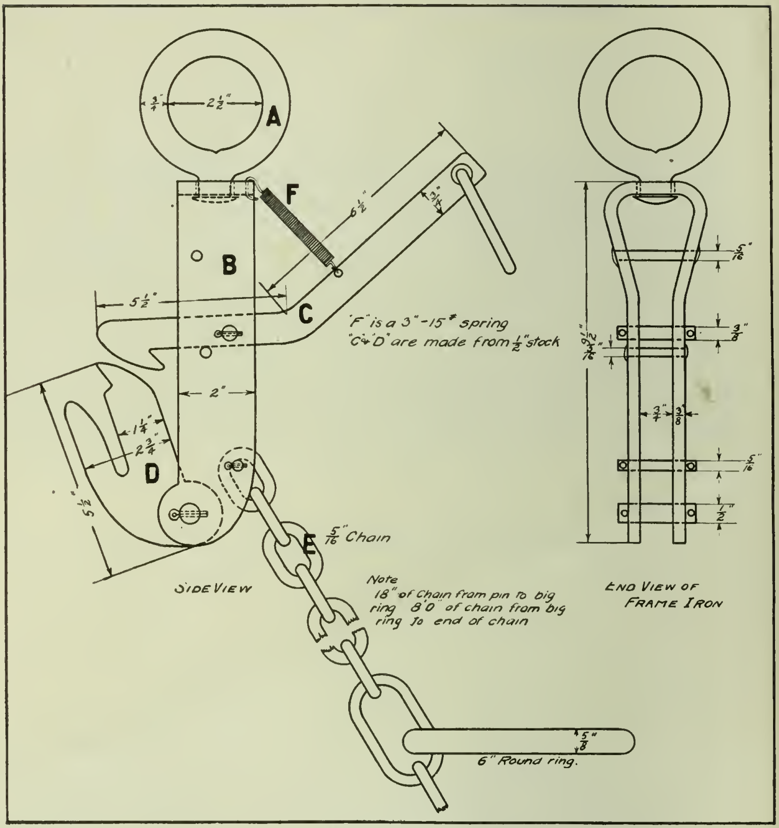

FIG. 22.—THE FROST TRIP

The Frost trip is composed of six parts. B is the body of the trip and parts D, E and C are held into place by three bolts respectively. D is the lip which engages the trip arm C and is held fast by the spring F. A is a swivel eye by which the trip is suspended from the boom. E is a 5/16" chain 9' 5" long with a large ring placed 10" from the trip. The operation of the trip is as follows: That part of the chain which extends beyond the large ring (or a circular hook with a narrow opening) is placed around the stump, drawn tightly, the end brought through the large ring and hooked up snugly into the lip, D. The 18" of chain between the ring and the trip is called the tag chain. Its purpose is merely to keep the choker chain attached to the trip where the choker chain is not engaged in the lip. Now as the stump is hoisted over the pile a sharp pull on the rope attached to the end of the trip arm C disengages the lip D which in turn releases the end of the chain and the stump falls on the pile. A 30' trip rope is attached to the arm C so that a release may be made at any time. A blue print of the Frost trip may be secured by writing to the College of Agriculture.

It was during the experimental work of 1918 that Warren Moore, foreman of the experimental crew, designed the circular hook with a narrow opening to replace the ring on the tag chain. He also made minor improvements in the trip.

COST OF LAND CLEARING

Brushing and stumping are two separate items of cost. Both of these are affected by labor conditions. Both may be done by the farmer himself, or by a contractor. The contractor usually has better equipment and a trained crew. To compensate for this the farmer can use spare help at odd times. The farmer who has to be home morning and evenings to milk his cows must have something to do between milkings. In some cases it can be proved that these 10 hours do not actually cost the farmer more than 10 cents an hour.

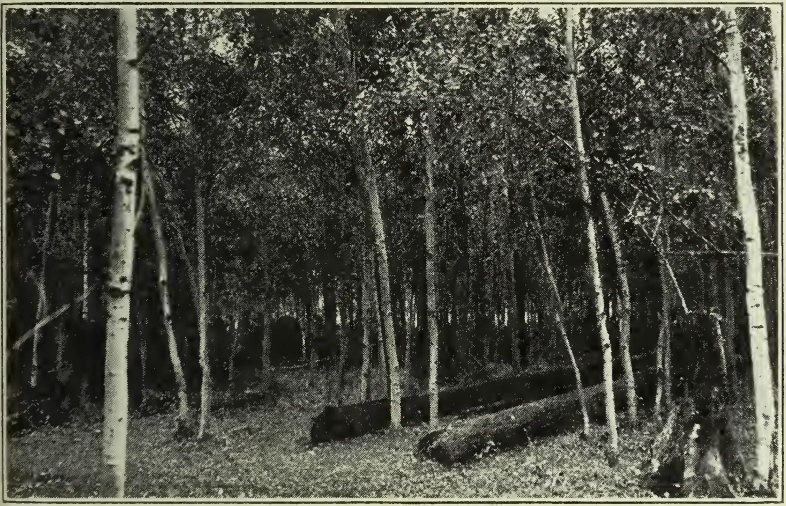

FIG. 23.—PASTURING BEFORE BRUSHING

Sheep killed the small brush in one summer.

Cooperation between neighbors enables each to profit by the other's spare time, as well as his own. Where neighbors buy equipment together and exchange help, the cost of land clearing is reduced to a minimum.

Brushing. Brushing costs the settler from nothing to about $30 an acre. It costs nothing where a villager is glad to chop and burn the brush and tops for the wood that he can save for fuel. In some cases the wood more than pays for the brushing. In the path of a forest fire or after pasturing like that shown in Figure 23, two men can cut and pile an acre in from two to four days, using a team on the down logs. The cost of removing the logs depends largely on the number of pieces to the acre large enough to require a team. The maximum cost is where there are many down logs and straggling trees with brush, like that shown in Figure 22. Where brush and logs are well piled (each separately) and have stood long enough to become dry the burning is a small item of cost.

The hay and pasture obtained from the land after brushing and before it is ripe for stumping, pay for the seeding and the cutting of the sprouts and return a profit. The next expense is that of stumping.

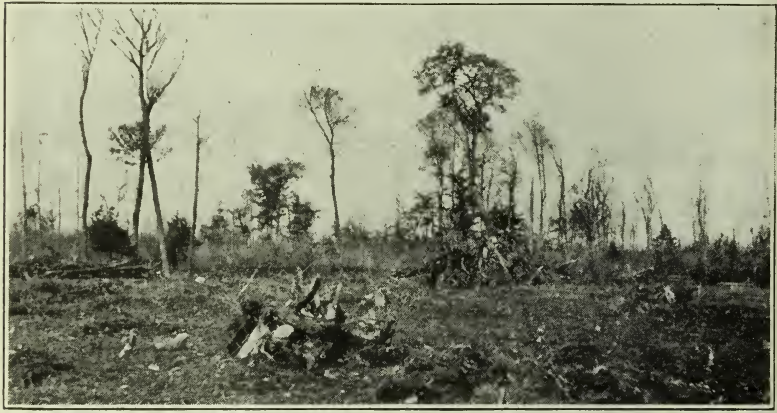

FIG. 24.—HARD CLEARING

Straggling trees, down logs, tree tops, and brush make a bad combination. The land in the foreground was stumped at a high cost because the hardwood stumps were green.

Stumping. The stump is the unit of cost. The cost of stumping can be estimated intelligently only after the stumps on a test acre have been counted and examined. The condition of the stump and the nature of the soil are factors. Wide spreading, shallow-rooted pine stumps are removed much more easily than the deeper-rooted stumps. A top-rotted hardwood stump with sprouts is frequently harder to remove than a green stump.

The accompanying photographs with the explanatory legends based on Table 2 give a general idea of the cost of stumping. The data were obtained by the stumping crew of the College of Agriculture during the investigations and demon-

TABLE II.—STUMPING RECORDS MADE BY THE CREWS AT THE DEMONSTRATIONS CONDUCTED BY THE COLLEGE OF AGRICULTURE OF THE UNIVERSITY OF WISCONSIN AND COÖPERATORS IN 1917.

PLACE	SOIL	DESCRIPTION OF STUMPS					DYNAMITE AND LABOR PER ACRE							
							Dynamite				*Pulling hours*		*Piling hours*	
		Kind	Age years	Diam. inches	Height	No. per acre	Pounds	Per cent	Caps	Blasting hours	Men	Teams	Men	Teams
Hines (a)	Red clay	Wh. pine	25	14.3	22	101	38	20	71	20	29	10	23	14
Hines (d)	Red clay	Wh. pine	25	12.6	22	53	64	20	59	9	....	....	16	5
Holcombe (a)	Sand loam	Wh, pine	30	16.5	38	106	45	40	27	9	32	12	29	13
Holcombe (d),	Sand loam	Wh. pine	30	19.4	38	104	287	40	172	58	....	....	50	26
Phipps (a)	Sand loam	Wh. pine	41	22.0	28	120	47	30	47	7	31	11	14	6
Washburn (b)	Red clay	Wh. pine	30	26.4	28	69	40	20	42	8	32	8	28	11
Washburn (c)	Red clay	Wh. pine	30	24.7	34	42	44	20	45	(f)	30	....	(e)	(e)
Washburn (d)	Red clay	Wh. pine	30	22.5	28	76	127	20	95	27	....	....	26	11
Mercer (b)	Sand loam	N. pine	21	9.6	(e)	163	9	20	6	½	24	6	11	3
Rhinelander (b)	Sand loam	Wh. pine	25	12.0	30	81	3	20	3	¼	12	3	6	3
Haugen (c)	Silt loam	Wh. pine	38	36.1	44	53	68	20	53	(f)	47	....	(e)	(e)
Haugen (d)	Silt loam	Wh. pine	38	28.6	44	39	141	30	114	55	....	....	17	7
Kennan (a)	Silt loam	Hardwood	9	12.9	18	108	5	20	9	1	29	10	15	8
Kennan (d)	Silt loam	Hardwood	9	13.1	20	116	139	30	144	47	....	....	26	9
Phelps (b)	Clay loam	Hardwood	8	13.0	20	118	13	20	17	1	23	6	13	6

(a) Cracked with dynamite before pulling with a capstan puller; (b) pulled whole with a capstan puller and then cracked with dynamite; (c) cracked with dynamite and then pulled with a one-man puller; (d) dynamite used alone to remove stump completely; (e) no record; (f) included under pulling. The records of the work at Joel, Frederic, and Laona are not reported in this table because they are incomplete. At Rhinelander 37 per cent of the stumps were decayed enough to be pulled without a hook or choker. This accounts for low cost.

strations of 1917. One man of the crew was available at all times to record the time and cost of each operation.

The average diameter of white pine stumps in Wisconsin is about 22 inches. This was the average diameter of the 120 stumps on an acre of the demonstration plot at Phipps. (See Table 2). The 120 stumps were cracked in the ground with 47 pounds of dynamite. It required 52 hours of man labor and 17 hours of team labor to crack with dynamite, pull with a capstan puller, and pile with a Conrath piler. Assuming that the stumping added $50 an acre to the value of the land, the returns for the labor expended amounted to about 60 cents an hour.

To illustrate the method of using Table 2 the cost per stump for the three methods used at Washburn is taken for an example.

> Assuming wholesale prices for dynamite and 20 cents an hour for the cost of man labor and the same for team labor, the cost per stump is: Pulled whole with a capstan puller and then cracked with dynamite—the pulling and cracking cost 26 cents, and the piling cost 11 cents, total 37 cents per 26.4 inch stump. Removed completely with dynamite—the removal cost 42 cents and piling 10 cents, total 52 cents per 22.5 inch stump. No record was made for the cost of piling the stumps pulled by a one-man puller, but the total was about 45 cents a stump.
>
> These results tend to show that to pull with a horse puller and then to crack with dynamite is the best of the three methods tried. Had the method of cracking first and then pulling with a capstan puller been tried, it might have proved more efficient than any of the other methods. At the demonstrations it was impossible to try this method. One interesting fact is that it cost 35 cents a stump to crack with dynamite and pull with a one-man puller, while it cost but 26 cents a stump to pull whole with a horse capstan puller and to crack with dynamite, the stumps averaging about the same diameter.

LAND CLEARING DEMONSTRATIONS

In 1914, Carl Livingston began studying the settlers' methods of clearing land. He collected information on land clearing methods and carried it from one community to another, perfecting or improving methods and devices where he could. In 1916 a special train contributed by the railroads, with equipment donated by manufacturing companies, carried the demonstration outfit from place to place in northern Wisconsin. In 1917, the work was given a backset by the untimely death of Mr. Livingston. The demonstrations did not begin until late in the season but were undertaken on a larger scale than ever before. Some experimental work was done.

The "coöperators." A train called the "Land Clearing Special" was operated in upper Wisconsin during a period of 13 weeks, making 15 stops in 14 counties and travelling on four different railroads. Part of the information presented in this bulletin was obtained on this trip. These railroads carried the equipment free of cost: Chicago, Milwaukee & St. Paul, Chicago & North Western, Chicago, St. Paul, Minneapolis & Omaha, Minneapolis, St. Paul & Sault Ste Marie.

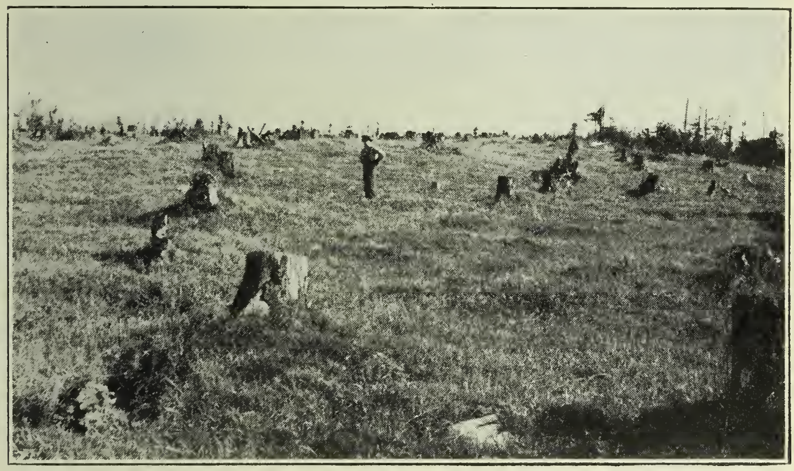

FIG. 25.—HARDWOOD RIPE FOR STUMPING

On an acre of this land there were 118 stumps consisting of 51 per cent hemlock, 30 per cent birch, 6 per cent maple and a few pine, basswood, elm, ash, and oak. See Phelps' data in Table II for cost and methods of stumping.

E. I. du Pont de Nemours Company furnished three experienced operators and dynamite for their own demonstrational and investigational work. Experiments were made with 20 per cent, 30 per cent, 40 per cent, and 50 per cent dynamites. The operators used No. 6 caps with fuse and No. 6 electrical caps, as well as punch bars, soil augers, and driving irons of the latest design. Electric blasting machines of all sizes were an important part of the equipment.

The Flynn Stump Puller Company of Superior, Wis., used its horse-power capstan machine and horse-power piler. The machine had a 22-foot sweep, 200 feet of inch cable, and five ⅞-inch chokers of various lengths. Only five wraps of the

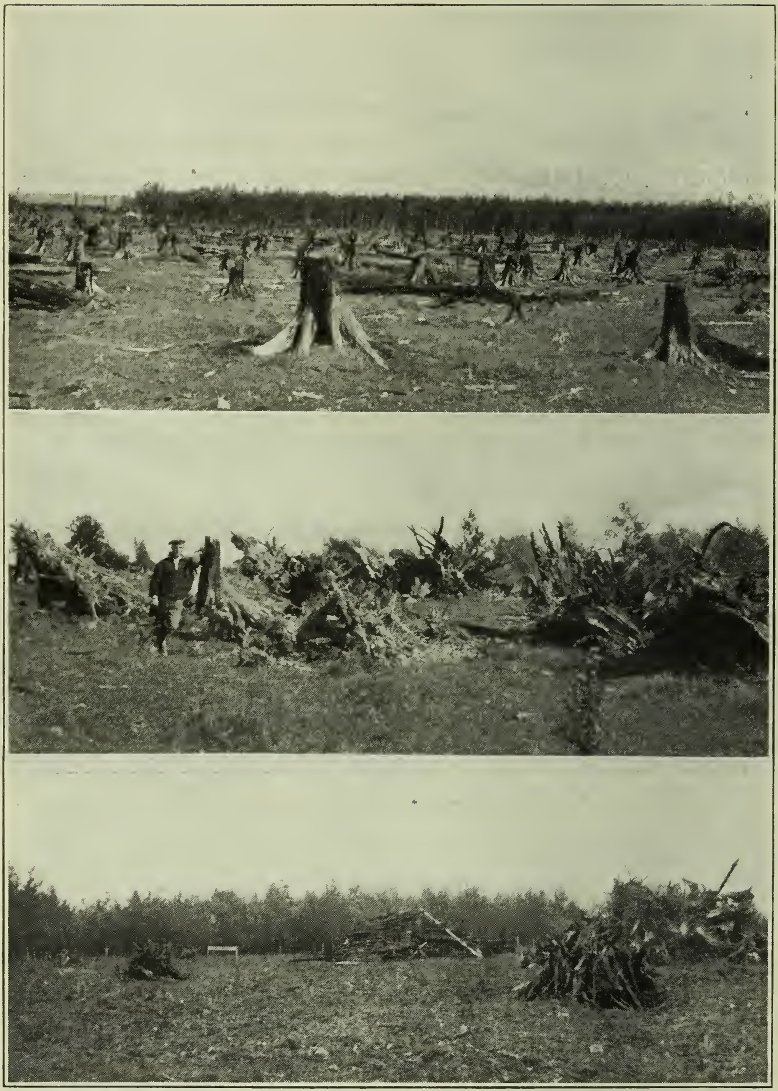

FIG. 26.—TYPICAL PINE STUMPING

Upper: Brushed, pastured and ready for stumping. Center: After the stumps were pulled and cracked. Lower: Piled and ready for burning. See Washburn data in Table II for cost and methods of stumping.

cable were kept around the drum and patented rollers were used for keeping the line tight on the drum. This machine, while requiring considerable room in which to operate, was very efficient in that several stumps could be pulled at once without stopping the machine while new chokers are being hooked to the main line.

The piler had a swinging boom and mast, and used tongs for taking hold of the stumps and an automatic trip at the end of the boom. With this machine stumps could be piled and burned at the same time. This method resulted in the more complete burning of green or wet stumps.

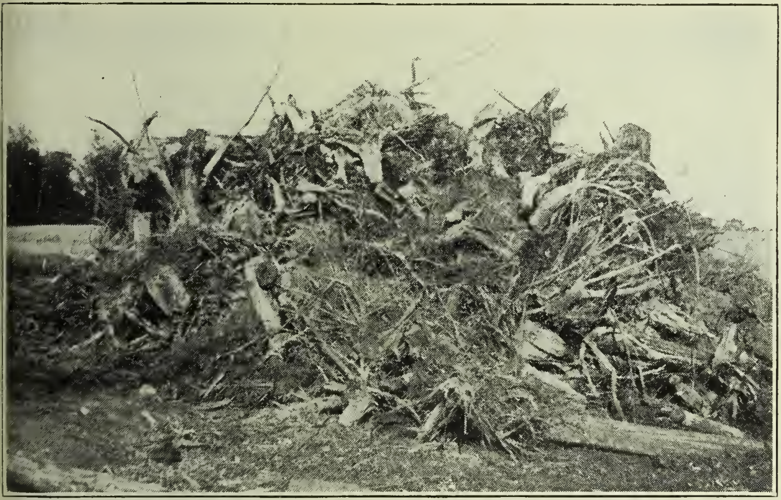

FIG. 27.—PILE OF GREEN STUMPS

Note the fibrous roots. It required more work to clean the earth from these roots than to pull out the stump. This kind of stumping is expensive and robs the soil of humus. Pasturing for a few years would have reduced the cost of stumping.

The A. J. Kirstin Company of Escanaba, Mich., furnished two horse-power machines and a one-man puller. The horse-power machines had ⅞-inch and ¾-inch main lines respectively, with extensions for extremely long pulls. As both machines had power pulleys and take-up chokers it was possible to pull stumps of any size. For extremely small stumps, group chokers were used.

The one-man machine consisted of a system of levers and clamps so arranged that seven different leverages could be exerted by one man on the sweep. Two pulleys were used to increase the power of the machine, making it possible to extract very large stumps.

The La Plant Choate Manufacturing Company of Cedar Rapids, Iowa, used its Steel Giant Horsepower Machine of the capstan type, using a ⅞-inch main line with an extension. Power pulleys, take-up chokers, and cluster chokers were used wherever needed. An improved root hook was designed by Mr. Choate on this trip.

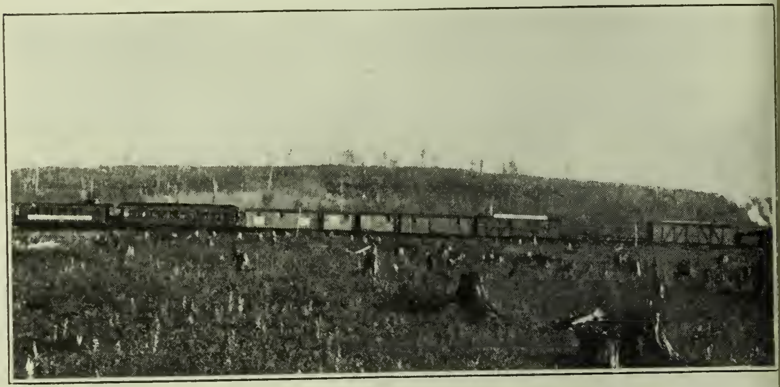

FIG. 28.—THE LAND CLEARING SPECIAL

This train carried the gospel of better land clearing tools and methods to upper Wisconsin.

The Merrill Iron Works of Merrill, Wis., added a gasoline power machine to the equipment. The machine was an experimental one and proved very interesting.

RESULTS OF THE DEMONSTRATION TRAIN

Cooperation was the keynote of the demonstrations—cooperation between neighbor and neighbor, farmer and merchant and farmer and banker. The dynamite man and the stump puller man worked together in an honest effort to work out and demonstrate better methods of stump removal. "Get rid of the stumps" was the slogan.

The demonstration proved that neither dynamite nor a stump puller alone is as efficient as a combination of the two methods. The advantage of the right combination was brough out clearly. The manufacturer and dealer accepted the ver dict with keen foresight. Anything that tends to make stump removal cheaper helps everybody.

Twenty per cent dynamite was found better in clay than 40 per cent. It is also cheaper. The low grade dynamite lifts more and shatters less than the higher grades. In sand the quick action of the 40 per cent is necessary.

The advantage of electric firing was established. This makes possible the distribution of the charge under a stump with a decayed top or spreading shallow roots. Safety dynamite devices developed by Mr. Livingston were demonstrated. These included the dynamite thawer and the safety cap box. Blue prints of these are sent upon application to the College of Agriculture.

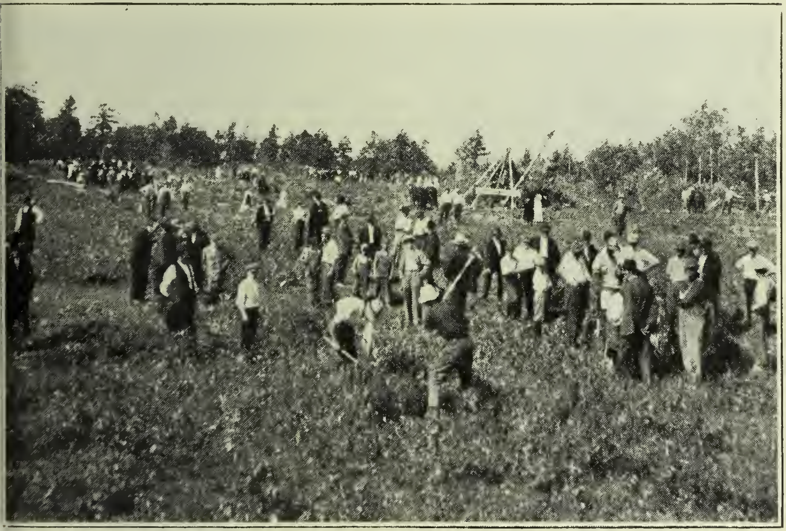

FIG. 29.—A STUMPING DEMONSTRATION

As many as 3,000 people came to a single demonstration.

The value of the accessories of the stump puller was demonstrated. A stump puller without take-ups, power pulley, root hooks, and plenty of cable is only half efficient.

The demonstrations brought the Conrath piler to many communities for the first time. Keen interest was manifested in this man-saving machine. Blue prints were distributed showing the details of the construction. When the supply was exhausted people were seen copying the plan so that they could go home and build one like the model. The Frost trip was improved during the demonstrations.

The organization of land clearing units of four or five neighbors to purchase machinery and equipment and to exchange help was urged. At Holcombe, the first land clearing unit was organized. For about $50 each six neighbors bought a stump puller with complete equipment. They elected a foreman and exchanged help to get a crew of five men. More of these land clearing units are needed in Wisconsin.

A greater respect was developed for modern engineering tools and methods. Land clearing was lifted to the plane of an art based on science. The aim was to reduce the cost and the backaches. The motion pictures of the evening meetings showed methods that could not be used in the field, either due to lack of equipment or to bad weather.

QUESTIONS FOR FURTHER STUDY

Methods of brushing. Many areas have been brushed and grassed and made ready for stumping easily. The question is, how has this been done? The farmer can recite his methods in a very general way but essential details of the methods are invariably lacking. Accurate data on the cost and method of brushing, and the method of seeding, pasturing, and haying would be valuable.

Cheaper grades of dynamite. Cheap grades of dynamite lower than 20 per cent may be used. The economy of this needs investigation. The proper amount of dynamite to be used in combination with the stump puller also may be standardized further than it is now.

Pulling before cracking or pulling after cracking. Another mooted question is the advisability of pulling before cracking as compared with pulling after cracking. Each method has its advantages and opinions vary as to its disadvantages.

Size of crew. Three men make a good crew for a stump puller. Perhaps a five-man crew is more economical. The only way to find out is to get comparative data.

THE LEGISLATIVE APPROPRIATION

The Legislature in 1917 placed a liberal sum at the disposal of the College of Agriculture for further investigations and demonstrations in land clearing. It was this appropriation that made possible the land clearing special for 1917 as well as the work for 1918.

EXPERIMENTAL WORK IN 1918

For 1918 the experimental work has been divorced from the demonstrational work. The experimental work was undertaken first. Between April 22 and August 14 the experimental crew of the College stumped 72 acres, using different methods for comparison. Table III gives a general description of the experimental plots. Three men were kept with the crew to record cost data for the different methods employed. Extreme care will be taken in analyzing these data before conclusions are announced. The matter of choice between two methods is a complicated one because of the variety of local conditions encountered. Unless the data are analyzed carefully in the light of these varying conditions, conclusions are apt to be misleading.

TABLE III.—EXPERIMENTAL STUMPING PLOTS, 1918

Place	Farm	Acres	Soil	Kind of stumps
Madison.......	College of Agriculture.....	5	Clay	Chiefly green oak
Holcombe.....	Kenneth Wilcox............	30	Loam	White and Norway pine
Owen..........	Owen Lumber Company....	12	Clay	White pine
Merrill........	Emil Maas..................	10	Clay	Hardwood and hemlock
No. Crandon..	County Poor Farm..........	15	Clay	Hardwood and hemlock

DEMONSTRATIONS IN 1918

The Land Clearing Special will make 18 demonstrations in six weeks ending September 27, 1918. The railroad service is authorized by the United States Railroad Administration, W. G. McAdoo, Director General. Cooperating with the College are: E. I. du Pont de Nemours Co., Wilmington, Delaware; A. J. Kirstin Co., Escanaba, Michigan; LaPlant-Choate Mfg. Co., Cedar Rapids, Iowa; Chicago, Milwaukee & St. Paul Railway; Chicago and North Western Railway; Chicago, St. Paul, Minneapolis & Omaha Railway; and the Minneapolis, St. Paul, & Sault Ste. Marie Railway.

Each cooperator furnishes one or more men. For instance, in the crew of three men and a team used for operating a stump puller the stump puller company furnishes one man, the college one man, and the land owner one man and a team. The railroads make no charge for hauling the seven cars of equipment but the College is required to pay the railroad fare of the crew and to board them on the train.

The itinerary of the Land Clearing Special in 1918 included demonstrations at Wausaukee in Marinette county, at Gillett in Oconto, Deerbrook in Langlade, Hatley in Marathon, Arpin in Wood, Greenwood in Clark, Westboro in Taylor, Ashland Junction in Bayfield, Drummond in Bayfield, Shell Lake in Washburn, Comstock in Barron, Hillsdale in Barron, Clear Lake in Polk, and Woodville in St. Croix, all on white pine stumping.

At Bowler in Shawano county, and Park Falls in Price the stumping was with white pine and hardwood. The demonstration at Fenwood in Marathon was on hardwood, and at Glidden in Ashland on white pine and poplar.

The county agricultural agent, cooperating with the local committee, made the local arrangements for the demonstrations.

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Wisconsin Bulletin 296 September, 1918

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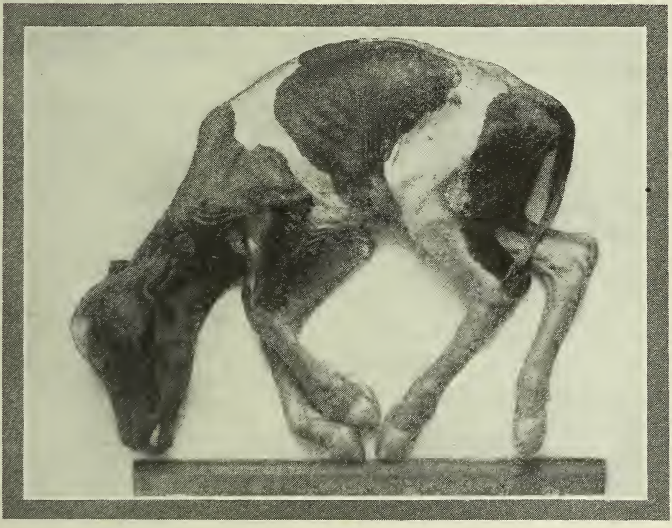
Contagious Abortion Questions Answered

DR. F. B. HADLEY



AN ABORTED FETAL CALF

The mother of this fetus was purposely infected with a large dose of the abortion germs four months after she conceived. This caused abortion during the seventh month of pregnancy. Note the development at this stage.

AGRICULTURAL EXPERIMENT STATION
OF THE UNIVERSITY OF WISCONSIN

MADISON

THIS BULLETIN TELLS YOU

How heavy the losses from the abortion disease are. Page 3

How contagious abortion is caused. Page 5

How the abortion germ lives and grows. Page 5

How this germ enters the body. Page 7

How the bull may become infected. Page 9

How the abortion disease makes its way into a herd. Page 9

How cows act when affected. Page 12

How long after exposure abortion occurs. Page 13

How serious results may follow retained afterbirth. Page 15

How long after serving an infected cow the bull is dangerous. Page 16

How to account for sterility of cows. Page 16

How to tell whether cattle have the abortion disease. Page 17

How the blood tests are made. Page 18

How to draw a sample of blood. Page 19

How to manage a cow that has aborted. Page 22

How to remove a retained afterbirth. Page 23

How to determine whether a sterile cow would respond to treatment. Page 26

How immunity to abortion is developed. Page 27

How to tell whether an animal has any immunity. Page 28

How and when to administer abortion vaccine. Page 31

How to manage a herd infected with abortion. Page 33

How to prevent and control the abortion disease. Page 34

How properly to disinfect a stable. Page 36

Contagious Abortion Questions Answered

To produce the millions of quarts of milk that have put Wisconsin in the lead as the greatest dairy state, an immense number of cattle is kept on her farms. Of all the diseases to which these cattle are subject, the abortion disease is by far the most common and important. This circular has been written to answer the many questions that owners of affected animals ask.

Although there are some vital questions about this disease that remain unanswered, it is highly desirable that the facts which are known be available for the information of interested persons, as it is only through an understanding of the nature of the malady that it can ever be brought under control. Our lack of knowledge about certain phases of the abortion disease has made it necessary to answer some questions incompletely. Later it is hoped that experiments now under way may shed light upon these obscure conditions.

NATURE, EXTENT, AND CAUSE

What does the term "contagious abortion" mean? The term "contagious abortion" is misleading and not sufficiently comprehensive to warrant its use in connection with the disease to which it is popularly applied. To illustrate—it conveys the impression that the fetus must be expelled before it is mature, which is not true. Moreover, it does not even imply that many other grave changes may occur as a result of abortion infection. Therefore, it is desirable to use the more extensive term, "abortion disease." The only justification for employing the term "contagious abortion" in the title is because it has been in use so long that most livestock men know the disease only by this name.

What does the term "abortion disease" mean? The term "abortion disease" is applied to an affection of cattle that is produced as a result of the invasion of the body by a certain germ, that can be transmitted to other animals, that affects several animals in many herds, and that runs a course of weeks or even months. Scientifically it is known as an infectious, communicable disease of cattle, chronic and insidious in nature, that confines itself largely to the organs of reproduction.

By what other names is the abortion disease known? Besides contagious abortion, this affection is known as infectious abortion and epizootic abortion. Some farmers refer to it as slinking or slipping the calf; others as premature birth of the calf.

What is known about the prevalence of this disease? The abortion disease is the most widespread of all diseases to which cattle are subject. The majority of purebred dairy herds are known to be infected, while it has also been reported in many beef herds. It is found in many recently settled communities and on open ranges through having been introduced with breeding stock. Although it is true that the abortion disease may disappear as suddenly from a herd as it appeared, there is a far greater probability that it will smolder in the herd for years, occasionally breaking forth, until often more than 50 per cent of all the cows have aborted and 75 per cent have become infected.

What losses result from the abortion disease? The calf is either born dead or is so weakened that it soon dies. Often there is a reduction in the milk flow of the cow for nearly a year. Frequently the afterbirth is retained and pus accumulates in the womb which may result in either acute generalized infection (blood poisoning), or chronic catarrh of the uterus with subsequent sterility. The latter condition reduces the value of the affected cow, and even if conception does take place, there is a likelihood that abortion will recur a second or even a third time. The secondary troubles just mentioned cause greater losses and are more difficult to control.

What is the approximate yearly loss from the abortion disease in Wisconsin? It is estimated that about 8 per cent of all milch cows abort each year. Assuming that the loss is $25 a head, which certainly seems to be a reasonable estimate, considering the high prices of feed and milk, the total loss for Wisconsin can be computed if the number of cows is known. The census reports for 1917 give the cow population of Wisconsin as 1,785,000 head. On this basis the annual loss would be about $3,570,000. This figure represents in a measure the stupendous toll levied by the abortion disease and its great economic importance to Wisconsin's farmers. It is apparent that the loss per cow to owners of purebred animals is much more than to those who own grade and common cattle.

What is the cause of contagious abortion? A microorganism or minute germ (the abortion bacillus of Bang) is known to be the sole cause of contagious abortion. A very powerful microscope is needed to see the organism on account of its extremely small size. It should be understood that other germs may invade the tissues after the abortion organisms have caused damage. These organisms are the ones often responsible for sterility and the other complicating diseases.

On what does the abortion germ thrive best? Fetal tissues and milk are best suited for the growth of the abortion bacillus. It can also live for some time in the womb and womb discharges after abortion has occurred. From the fact that its natural foods are produced in the womb and udder, it follows that these organs would most frequently become infected and act as the abode of the germ.

Can the abortion germ grow outside the body? Although it is difficult to get the germ of abortion to grow on artificial culture media when first isolated, after a few generations it can be propagated without difficulty in the laboratory. (See section entitled ''Means of Diagnosis.'')

How long do abortion germs live outside the body? Without knowing the conditions under which the germs are situated, a definite answer cannot be made to this question. Under experimental conditions the germs soon die upon direct exposure to sunlight. In moist places they may live for weeks or months. We have isolated the germ from a fetal calf that had been solidly frozen for 24 hours, so freezing for this length of time does not kill this organism. Bang and Stribolt were able to isolate the abortion bacillus in pure culture from two fetuses that had been dead five and nine months respectively. The uterine discharge kept on ice contained living organisms after seven months. Therefore, it is evident that the germ may live for long periods outside the body, but it does not increase in numbers under such conditions.

Does abortion occur in cattle from other causes than infection with these germs? Practically all abortions are due to contagion and the sooner the cattle owner realizes this, the sooner will he be able to prevent further losses. However, a continuous high fever from any cause may produce abortion. Injuries or defects that damage the womb or fetal membranes or in any way disturb the nutrition of the fetus may also cause cows to abort. It is extremely doubtful whether slipping, goring, kicks, falls, and similar accidents ever cause abortion, the opinion of many dairymen to the contrary notwithstanding.

FIG. 1.—COWS AT PASTURE IN WISCONSIN

It is in such valuable purebred dairy cattle as these, the progeny of which is worth thousands of dollars, that the abortion disease produces the greatest losses.

Are certain feeds capable of producing abortion? It is known that a ration composed of wheat and other products of the wheat plant reduces the resistive power of the cow to diseases and often causes her to calve prematurely. Experiments conducted at the Wisconsin Agricultural Experiment Station point to a lack of sufficient mineral matter in the wheat ration as one disturbing factor and to some poisonous material, as yet of unknown character, as another. Corn, on the other hand, contains all the elements necessary for successful growth and reproduction. There is little reliable evidence to support the common belief that moldy, spoiled, and smutty grain or roughage is capable of producing abortion. Practically every attempt to produce abortion by feeding pregnant cows such feeds has failed.

Does contagious abortion ever occur in other species of farm animals? Reports of serious outbreaks of abortion in mares, sows, and ewes are on record. However, a specific germ for each animal species has been found responsible for the abortions. In other words, contagious abortion of cattle is not transmissible to horses, swine or sheep, or the forms affecting these animals to cattle under natural conditions. We have produced abortion experimentally in ewes by injecting large doses of the germ that causes the disease in cattle. Under ordinary farm conditions there is no evidence to show that ewes or other species of farm animals ever abort as a result of infection with the germs that cause cattle abortion.

ACQUIREMENT OF NATURAL INFECTION

Is the abortion disease ever inherited? We have demonstrated the presence of abortion germs in the stomach contents of prematurely born calves, but their dams also were always found to be infected. These calves probably acquired the infection through having swallowed placental fluid containing the abortion germs. This does not constitute inheritance in the biologic meaning of the term. The blood tests, that will be described later, show that an infected cow always gives birth to an infected calf. When the cow is not infected the calf fails to react to the blood tests at birth.

How do the germs of abortion gain entrance to the body? The abortion organisms may enter the body by any one of the following paths: the digestive tract, with the food or drink; the genital tract, during sexual intercourse or by contaminated objects and fluids introduced either intentionally or accidently; the broken skin, as a cut or wound; the udder, either by penetration from the inside or introduction through the teat canal.

Does age make any difference in liability to abortion? Heifers are undoubtedly more apt to become infected than are calves or cows. A careful study of diseased herds has shown that more than 80 per cent of the cases acquire the infection before the second calving. The most favorable time for infection to gain entrance seems to be shortly after the heifer has dropped her first calf and when the mouth of the womb is still open. Many heifers must become infected earlier, else they would not abort their first calf.

Why are heifers more frequently affected than older cows? Apparently the heifer has less resistance to the abortion germs than the cow, which seems to develop more or less protection against these germs. (See section entitled "Development of Immunity.")

What percentage of heifers abort? Although heifers acquire the abortion disease and abort more frequently than do cows, heifers in different herds show a great difference in their ability to withstand the effects of the disease. If the disease has established a firm foothold and no steps are taken to control it, a large percentage of the heifers is likely to abort. In one very large herd on which careful records were kept over a period of three years, 1,238 heifers conceived. Of these, 195, or 16 per cent, were known to have aborted.

When do cows become infected? If abortion occurs early in the gestation period infection must have taken place near the time of breeding. In cases where the fetus is carried seven months or longer, it is highly probable that infection occurred sometime after conception. The statement has been made by one investigator that once the uterine seal, which forms shortly after conception, is perfected, there is no danger of infection occurring, and the cow will carry the fetus to term. At present we are not at all certain that this is true.

At what age may calves become infected? Calves may acquire the disease before as well as after birth. In our experimental work we have found that the newborn calf of an infected cow usually reacts to the blood tests in the same way as the dam, so it must have become infected before it was born. That the fetal calf swallows the fluid surrounding it is shown by finding its hairs and the germs in the stomach. When calves are fed from birth on raw milk containing the abortion germs they seldom react to the blood tests. This would indicate that the calf is not easily infected by way of the digestive tract.

Does the bull become infected? With a few notable exceptions, all attempts to isolate the specific abortion organisms from the bull have failed. In fact the bull is often the only member of a diseased herd that is free from infection with this germ. Unquestionably, the male often becomes infected with the germs that produce the various secondary diseases in the female, which are properly classed under the more inclusive term "abortion disease."

How may a bull become infected? Mating with an infected cow appears to be the most common way. Other ways of infection are the same as those mentioned for the cow.

After a cow aborts once, is it true that subsequent abortions are always due to the original infection? Most certainly not, as it is quite possible that a new or re-infection of even greater virulence than the former has occurred from a fresh source. In such a case the cow might abort earlier than she did the first time. Some authorities believe that later abortions may be due to the organisms that are responsible for the complications which follow abortion.

Are all breeds of cattle equally susceptible to abortion infection? There appears to be no difference in the susceptibility of different breeds of cattle to abortion infection. However, as there is more traffic in certain breeds than in others, a greater chance of spreading the disease among them is possible. Investigation shows that cattle of these breeds are more often infected. Until recently range cattle, which belong largely to the beef breeds, were relatively free, but now many of them are known to be affected. It is reasonable to believe that under exactly similar surroundings cattle of different breeds would acquire the disease with the same uniformity.

METHODS OF SPREADING ABORTION DISEASE

By what means may abortion be introduced into a herd? The most common source of infection is the cow which has a vaginal discharge as a result of abortion infection. Raw milk and milk products containing the germs are thought by some to be factors in the spread of the disease. Less frequently than has been supposed does the bull introduce abortion into a herd, yet, as has been pointed out, the bull may act as a mechanical carrier of the germs. It may be impossible to find out the exact way in which the disease made its way into a given herd.

When is an aborting cow most dangerous to others? Just before and just after a cow aborts she gives off large numbers of abortion germs in the discharge from the vagina. Often this fluid is literally alive with the germs. This discharge is capable of infecting other cows and is the most common and important agent in the spread of the disease from one animal to another and one herd to another.

FIG. 2.—A "CARRIER" OF ABORTION GERMS

Although this cow is apparently healthy, she has been affected with the abortion disease for six years. During this time she aborted three fetuses and gave birth to three normal calves. There is every reason to believe that she has been the means of infecting many other cows in the herd.

What is meant by a "carrier" of disease? A disease carrier is an animal that has had an attack of a certain disease and recovered, but is still discharging in the secretions and excretions of the body the living, virulent germs. If these germs get into the bodies of other susceptible animals they are capable of causing the same disease.

Are cows ever carriers of the abortion germs? Some cows have been known to act as carriers for several years after they have ceased to abort, their milk containing the germs continuously. What is even more important is that some cows which have always calved normally may be carriers and spreaders of abortion germs. There is proof that the udder acts as a breeding ground for the germs. In non-pregnant cows the udder seems to be the only organ in the body where the abortion bacilli can live.

May calves be the means of transmitting the infection? There is some reason to believe that calves while being fed on milk containing virulent abortion bacilli may be a factor in the spread of abortion. Therefore, to be on the safe side it would be well to postpone introducing calves from a herd in which abortion exists until at least one month after all raw milk has been withheld from their ration.

What part does the bull play in spreading the disease? Conflicting views prevail among livestock men in regard to the importance of the bull as a disseminator of contagious abortion. The writer and assistants have carried out a carefully controlled experiment to shed light on this important question. Abortion-infected bulls were mated with abortion-free, virgin heifers. A full report of this work is printed in the Journal of the American Veterinary Medical Association, November, 1916. The conclusions are summarized:

(1) Bulls may become infected with abortion bacilli.

(2) Bulls that reacted to the blood tests were incapable of disseminating the abortion disease to the virgin, abortion-free heifers with which they were mated.

(3) Bulls appear to possess a sexual or individual immunity to abortion infection that renders them less susceptible than cows and induces a milder form of the disease.

(4) Bulls, when infected, have the ability to weaken the infecting germs of abortion in their bodies in a relatively short time, so that they will be safe for the service of non-infected cows.

(5) Cows usually acquire the abortion disease from other cows instead of the genitalia of bulls at time of service, as has been supposed.

Is it dangerous to permit a bull to serve a cow that has previously aborted? It has been shown that the bull seldom acquires the disease. This should not be taken as meaning that he may not act as a mechanical carrier of various disease-producing germs from an infected to a healthy cow. Therefore, the precautions detailed elsewhere should be taken in caring for the bull. Even if he has been permitted to serve a cow that is later learned to have aborted, the danger to cows subsequently served would not be so great as from other cows in the herd that are known to have harbored the infection.

Is there danger of spreading abortion by means of milk? There is no doubt that mixed whole milk, skimmed milk, and buttermilk from several herds contain living abortion germs. When this is fed to calves there is a probability of their becoming infected. To prevent the spread of milk-borne diseases, the Wisconsin State Department of Agriculture requires the owners of all creameries, skimming stations, cheese factories, and condenseries to pasteurize all by-products before returning them to any farm or feeding station. The strict enforcement of this regulation should be a decided help in preventing the dissemination of the abortion disease, as well as all other infectious diseases of cattle, particularly tuberculosis.

Would there be danger from a pasture in which a cow aborted? In a previous answer it was shown that the life of the abortion germ outside the body varies quite widely with conditions. However, it is certain the alternate freezing and thawing that occurs during the winter and spring months, combined with other natural destructive agencies, can be depended upon to weaken all abortion germs that may have been left in a pasture by infected cattle before the next spring, so that no danger need be feared.

Effect on the Animal

What are the symptoms of abortion infection? During the early months of pregnancy no symptoms of abortion infection are evident. If the fetus dies at this stage, it is expelled without causing any marked disturbance. Later in pregnancy abortion is announced by swelling of the udder, congestion of the external genital organs, thickening of the milk, and a vaginal discharge of a red-brown or gray color which may or may not have a bad odor. The afterbirth is often retained and the cow may develop a stinking discharge from the uterus that will prevent conception. It should be understood, however, that cows may be infected with abortion without showing any of these symptoms. This means that actual abortion of the fetal calf does not have to occur to constitute abortion infection—an important fact not generally appreciated.

In what organs of the cow do the germs usually locate? The space between the walls of the uterus and the fetal membranes is the place where the germs find conditions especially well suited for growth. They may also locate in the fallopian tubes. The udders of some cows have been found to harbor the abortion germs for long periods.

How is the uterus or womb affected? It is in the uterus that abortion infection produces the greatest amount of damage. Here the germs multiply in such numbers as to interfere with the passage of nourishment between the mother and the fetus. This usually results in death of the fetus and often is followed by retention of the afterbirth. A sequel in many cases is an accumulation of pus in the womb. This is caused by pus-producing germs which gain entrance at the time or after the fetus is expelled. In such cases sterility is likely to result either from the inflammation that accompanies the condition or from the pus itself.

How long after exposure will a cow abort? The incubation period of abortion, or the time between the entrance of the germs into the body and the occurrence of abortion, varies with the resistance of the animal and the virulence of the infecting germs. When the resistive forces of the body are high and the virulence of the organism is low, the animal does not abort until late in pregnancy or may never abort. On the other hand, if the resistive forces are weak and the abortion germs are strong in either number or virulence, especially in both, the incubation period is short and the course of the disease is rapid. In this case abortion occurs early.

At what period of pregnancy does abortion usually occur? There is no set period at which abortion may be said to occur. Some cows abort so soon after being bred that none of the characteristic symptoms of abortion are evident and the fetus is so small as to escape notice. Other cows do not abort until the sixth or seventh month of pregnancy.

Does infection with the abortion germs always result in abortion? When the abortion germs lack the necessary disease-producing properties, or the cows have marked resistance, abortion does not occur. Moreover, when the germs do not get into the body until late in pregnancy they do not have time to produce enough damage to interfere seriously with the nutrition of the fetus and to cause its premature expulsion.

How long may the germs of abortion live in the cow's body? Undoubtedly there is a great difference in the ability of different cows to throw off the germs. Schroeder and Cotton believe that the germ lives but a few weeks in the empty uterus, but in exceptional cases may inhabit the udder for months or even years. The reason for this would seem to be a lack of suitable food material in the former organ and a plentiful supply in the latter.

FIG. 3.—COW INFECTED WITH ABORTION DISEASE

This cow aborted a 197-day fetus March 6, 1918. The specific germs of abortion were recovered from the liver of the fetus by inoculating one of the guinea pigs shown in Fig. 4.

When do the germs of abortion exert their greatest damage? After the uterine seal is formed the air is shut out and the fetal tissues develop. These conditions are most suitable for the growth of the abortion germs and it is then that they produce the greatest harm.

What is the cause of retention of the afterbirth or placental membranes? Retained placenta is always the result of metritis or inflammation in the womb. Metritis is caused by the germs of abortion and of other infections, as well as by filth and mechanical and chemical irritants. Retention of the placenta should be regarded as a complication of, or secondary to metritis. The inflammatory changes are often accompanied by swelling in the cotyledons which prevents ready separation of the fetal and maternal membranes.

What are the symptoms of retention of the afterbirth? The symptoms of this condition vary with the length of time that has elapsed since calving. Usually a portion of the membranes hangs from the vagina, but sometimes nothing is visible. A discharge of varying degrees of offensiveness is always present. Neglected cows develop a fever and lose appetite.

What may be the results of retention of the afterbirth? When the fetal membranes become putrid the cow may develop one or more of the following symptoms of disease: (1) loss of appetite; (2) reduction of milk; (3) loss of flesh; (4) blood poisoning; (5) inflammation of the womb with accumulation of pus; (6) a foul-smelling, persistent discharge; (7) sterility; (8) death.

How has it been shown that the udder may become infected with abortion germs? Schroeder and Cotton have repeatedly demonstrated that when abortion bacilli are injected into the udder through the teat, the bacilli establish themselves in that organ and the cow becomes infected. Other investigators have shown that milk drawn under sterile conditions may contain these organisms.

Do the abortion germs bring about any visible change in the udder? Careful pathologic examinations of the udders of cows that were known to have continuously eliminated the germs of contagious abortion in their milk for a long time previous to slaughter failed to show visible lesions of any kind.

Can the abortion germs pass from other points of entrance to the uterus? Positive proof is available that once the germs of abortion get into the body they are capable of passing to the uterus.

Do the ovaries ever become infected? It is believed that certain ovarian diseases which destroy the egg-producing functions of the ovaries are due to the inroads of the abortion bacilli, although in the opinion of Bernath the other germs that gain entrance to the genital organs after the calf is expelled are responsible for the ovarian disturbances.

Does the blood contain the germs? Very rarely, if ever, does the blood under natural conditions contain the germs.

Even the blood of non-pregnant cows, into whose veins abortion germs have been experimentally injected in great numbers, does not contain them after a few hours.

Does abortion infection always result in the death and expulsion of the fetus? The usual result of infection with the abortion germs is death and expulsion of the fetus before term. Occasionally when the fetus dies, it is retained for weeks or months and gradually dries up and assumes the condition of a mummy. Again the fetus is carried to full term and the calf is born alive, but is so weak that it either dies in a little while or fails to thrive. Some cows have enough resistance to withstand the attacks of abortion germs and give birth to calves that are in every way normal and healthy. For these reasons the act of abortion should not be taken as a basis for measuring the prevalence of abortion disease in a herd.

Does the bull harbor the germs? A much smaller percentage of bulls in infected herds become infected than of cows. The germs of abortion have been isolated from the genital organs of bulls in only a few cases. (See section entitled "Effect on the Animal.")

How long after serving an infected cow is a bull dangerous? There is every reason to believe that a bull which has served an infected cow will be able within a few weeks to free itself of all abortion germs which may have contaminated its genital organs at the time of service.

What is the most common complication or sequel of abortion infection? The commonest and most serious complication of contagious abortion is sterility or barrenness. This affection causes even greater losses than abortion.

Is sterility due to other causes? Yes, a number of other germs, particularly those that produce pus, may cause sterility. These are more likely to be present if the cow has had difficulty in calving or a retained afterbirth and pus have collected in the uterus. Still other causes are overfeeding and lack of exercise, diseases and defects in other organs of the genital system, and certain nervous affections.

What are the symptoms of sterility? Some sterile cows come in heat regularly but fail to conceive even after repeated service; other sterile cows never come in heat.

How does sterility handicap the cow? It renders her incapable of producing young. Next to death this is the greatest disaster that can befall the purebred cow, for no matter how great her individual excellence, she is unable to transmit her attributes to posterity and is only fit for the block.

What may be expected from an aborting cow? Unless given early and expert attention, a cow which has aborted is not likely to prove profitable as a producer unless she either is above the average in point of production, or is of pure or especially good breeding. The reasons for this statement are: (1) the milk flow will be materially less than normal; (2) there is likely to be some difficulty in getting her to conceive promptly; (3) there is a decided probability that she will abort in the next gestation period. It should be noted, however, that when properly treated she may become the most valuable animal of the herd.

MEANS OF DIAGNOSIS

What is meant by the term "diagnosis?" Diagnosis is the art of determining the nature and location of disease. It is the first step towards intelligent prevention and treatment. In a word, it is detecting what ails the animal.

How may the abortion disease be diagnosed in a herd? Besides the history of the herd, which is invaluable in making the diagnosis, there are several laboratory tests that are capable of detecting abortion infection. The two tests that have been found most reliable are: (1) the isolation of the abortion germs; (2) the blood test.

What is the procedure followed in isolating the abortion germs? The germs of abortion may be isolated from the aborted fetus, fetal membranes, uterine exudate, and infected milk by either the direct or indirect method. The direct method consists in placing minute particles of tissue on suitable culture media which are incubated under reduced oxygen pressure for several days at body heat. If conditions are right the organism will appear in transparent colonies about the size of a pinhead on the surface of the media. The indirect method consists in injecting some of the tissue believed to be infected into a guinea pig. The organism of abortion produces characteristic lesions in the liver and spleen of the experimental animal from which it may be recovered by the direct method. The indirect method is the more reliable and the one usually followed by laboratory workers.

Why are the isolation methods not used more generally? Because they require very careful technique, and consume much time, and suitable material is not always obtainable. Furthermore, on account of the difficulty in satisfying the conditions for growth of the abortion organism, they are frequently not successful even if the germ is present. In experimental work, however, they are of great value. The indirect method of isolation, although very reliable, is too slow and expensive to be used for testing large numbers of cattle.

How many kinds of blood tests are in use? Two, the complement fixation test and the agglutination test. They are recognized as the only practical methods of diagnosing contagious abortion on a large scale.

What do these tests demonstrate? They show the presence or absence of certain specific chemical substances, known as antibodies, that are produced as a result of the animal having become infected with the abortion germs. Although these blood tests indicate whether the antibodies are present, they do not demonstrate the presence of germs in a blood sample.

How is each test made? The complement fixation test is quite complicated as in making it the blood from animals of four different species must be employed.

The agglutination test is simpler and consists of adding graduated amounts of the blood serum of the animal to be tested to one cubic centimeter of a milky suspension of the abortion organism. The tubes are incubated for six hours and then placed in a refrigerator over night. When the organisms clump or agglutinate in the bottom of the tube and the liquid above is perfectly clear, the test is interpreted as positive and is indicated by a plus (+) sign. A negative reaction is indicated by a minus (—) sign.

Which blood test is the more reliable? There is little difference. At one time it was thought that the fixation test was in closer harmony with clinical data. This would be true only when this test is conducted with extreme care as to details of manipulation and interpretation of results. While neither test is infallible and capable of detecting all cases, both are as close to the actual condition as it is possible for any biologic test used in diagnostic work to come.

Does a positive reaction to the blood tests tell whether a cow will or has aborted? No, it simply demonstrates that the antibodies, produced as the result of the abortion germs, are present in the animal's body. A reacting cow may have aborted, may abort, or may never abort. When the blood sample is drawn very close to the time of aborting, the reaction is often less marked and may even be negative, while it would have been positive earlier or later. Furthermore, the disappearance of the germs from the animal's body is not followed at once by a disappearance of these antibodies.

How long after abortion will cows continue to react with the blood tests? For varying lengths of time. More continue to react, especially those with udder infection, than change from a positive to a negative reaction. The Station has records on some cows that have given a positive reaction every time the tests were applied over a period ofsix years.

How is a blood sample taken from an animal? The hollow, pointed needle of a veterinary hypodermic syringe is plunged through the skin into a vein. The blood may be drawn from a milk vein or a jugular vein, whichever is more convenient. If the latter is chosen, it first should be engorged with blood by drawing a rope tightly around the neck just in front of the shoulders. The animal's head is held to one side by a halter rope or "bull lead" in the nose. No special precautions are necessary except that the needle be clean. The blood is caught in a sterile test tube or small bottle *as it flows from the needle.*

Where can one have these blood tests made? At the Veterinary Science Laboratory of the College of Agriculture, University of Wisconsin, Madison.

What is the charge for making blood tests? A charge of 10 cents is made to residents of Wisconsin for testing each blood sample. This is only enough to cover the cost of materials actually used. Residents of other states are required to pay 25 cents per test. Remittances may be made by stamps or check.

Is there a test for abortion that may be made in the stable? A diagnostic test fluid known as abortin, which is prepared and used much like tuberculin has been employed, but the results from its application have been so unsatisfactory that it is no longer used. A physical examination is not reliable as a means of diagnosis.

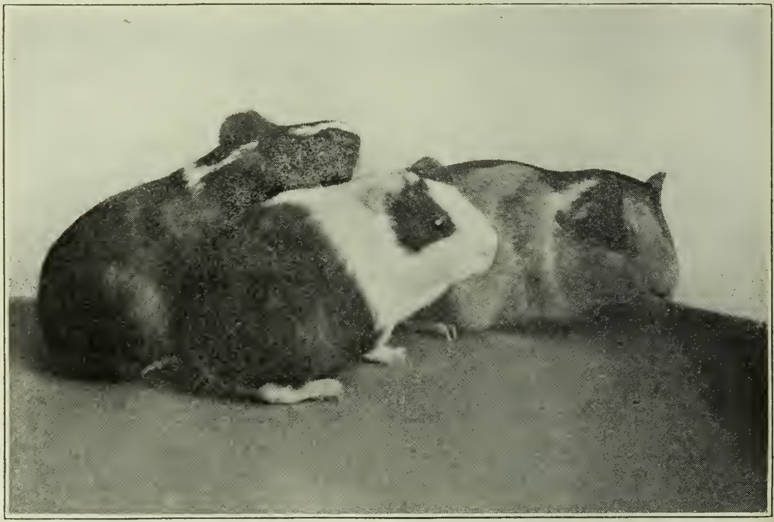


FIG. 4.—AIDS IN DIAGNOSING ABORTION

One of these guinea pigs was inoculated with liver tissue from the aborted calf of the cow shown in Fig. 3; the others with laboratory cultures of the abortion bacilli. After six weeks they were killed and from the internal organs of each the germs of abortion were recovered.

Is there any other way of telling whether a cow is going to abort? Shortly before abortion occurs certain symptoms similar to those preceding normal parturition may be observed. They are not entirely reliable for even after showing these symptoms the affected cow may have sufficient resistive power to overcome the effects of the germs and deliver a full-term calf.

Are the lesions produced by abortion infection characteristic enough to aid in making a diagnosis? The fetal membranes in many cases show a brownish or yellowish pus-like material on the outer surface of the external membrane and a necrotic or rotted appearance of many of the cotyledons. Subsequently a uterine discharge is likely to occur, more especially if the membranes fail to come away promptly.

Does a retained afterbirth always indicate the abortion disease? It is apparent that retention of the afterbirth is a frequent result of abortion infection. However, there are other causes for this condition; therefore, it cannot be said to be a certain sign of abortion in every case.

How may it be shown that the blood tests indicate the progress of abortion in a herd? The figures in Table I show the condition of a herd over a period of five years. It should be stated that while every reacting cow did not abort in the year she first showed a reaction, most of them had aborted or did abort eventually. On the other hand, several that never reacted aborted, which indicates that the tests are not 100 per cent accurate.

TABLE I.—PROGRESS OF ABORTION IN ONE HERD AS SHOWN BY REPEATED BLOOD TESTS

Year	Number of reactors	Number of non-reactors	Total number	Per cent of reactors
1913	8	26	34	23.5
1914	11	46	57	19.3
1915	22	34	56	39.3
1916	23	34	57	40.4
1917	18	37	55	32.8

What percentage of the cows and heifers in infected herds react to the blood tests? About 36 per cent of all cows in herds where the disease is known to exist respond to the blood tests. This figure is based on tests carried out at this Station on more than 6,000 head of cattle.

How do calves from reacting cows respond to the blood tests? New-born calves almost always give the same blood reaction as their mothers. As they get older those that have reacted gradually become non-reactors. When they reach breeding age most of them give a negative reaction. Later in life there is no appreciable difference in the proportion of abortion in daughters of positive and negative reacting cows. This fact tends to disprove the statement that the calves of infected cows harbor a latent infection which "lights up" when the animals become pregnant and frequently results in abortion.

How do calves fed on milk containing the abortion germs react? At the Michigan Agricultural College calves were fed milk containing the abortion germs. After varying lengths of time their blood was tested, but very rarely was a calf found that gave a reaction. At the Wisconsin Agricultural Experiment Station calves that did react when young failed to do so after a few weeks. These experiments would indicate that the germs do not usually stay in the bodies of calves for any length of time.

TREATMENT FOR ABORTION, RETAINED AFTERBIRTH, AND STERILITY

Will a cow recover from the abortion disease without treatment? There is a prevailing belief that by letting the disease run its course it will die out without treatment. This belief is based upon the assumption that the cattle will develop immunity. While it is true that some cows do recover of their own accord, it is well known that the majority not given treatment are left more or less impaired. If the system of management described here is followed, the results will be far better than if nothing is done to combat the disease.

Can the abortion disease be cured? It seems reasonable to believe that animals affected with the abortion disease can be cured, for experience teaches that animals affected with many other infectious diseases have been cured. Moreover, it has been shown that when the uterus of an aborting cow is given a chance to heal, all disease-producing germs are eliminated from it in a relatively short time.

How should an aborting cow be managed? Immediately after a cow aborts, and before, if symptoms of abortion are evident, she should be removed from the herd to a specially prepared stall for observation and treatment. This may also be said of cows with retained afterbirth and a vaginal discharge. The fetal calf, afterbirth, and contaminated litter must be disposed of at once in a sanitary manner. The place where the cow stood should then be well saturated with a reliable disinfectant prepared according to the directions of the manufacturer. The cow's rump, tail, vulva, and thighs should receive a daily thorough scrubbing with a warm disinfectant solution while there is any vaginal discharge noticeable. The vagina should be douched at once with warm one per cent salt solution.

How is the one per cent salt solution prepared? Two level tablespoons of common table salt are dissolved in one gallon of freshly boiled, blood-warm water. This is a sufficient quantity for one treatment.

If the afterbirth is retained, what should be done? A competent veterinarian should be called to determine whether the afterbirth should be removed at once. Intelligent, persistent treatment along the lines to be described is necessary in these cases if affected cows are expected to recover. Most cases of garget, blood poisoning, and subsequent sterility can be traced to failure to remove retained afterbirths at the proper time.

When should a retained afterbirth be removed? Normally the afterbirth loosens and drops of its own accord within a couple of hours. If it does not, there is no cause for immediate worry. It is impossible in the majority of cases to remove these membranes completely within the first 48 hours on account of their close union with the cotyledons or ''buttons.'' The best time to attempt removal is between the 48th and 84th hours. At this time the ends of the uterine horns are more easily reached, the membranes can be separated from the cotyledons with greater facility, and will come away without tearing into shreds. In all cases where the placenta loosens earlier, it should be removed promptly, but force should never be used to remove a placenta, as the germs of abortion have already caused some damage and intensified the susceptibility of the cow to the other forms of infection which are always present awaiting a favorable opportunity for attacking the womb.

How should a retained placenta be removed? Both skill and judgment are needed by the veterinarian in removing a retained afterbirth. Several gallons of the warm one per cent salt solution already described should be injected into the womb by means of a uterine catheter or a soft rubber tube, to one end of which a funnel is attached. A double layer of clean muslin should be placed over the funnel to prevent the passage of dust and dirt. By attaching a pump instead of a funnel to the hose, the fluid can be forced further into the uterus, which is an advantage. Some veterinarians prefer a weak antiseptic solution, especially when the membranes are putrid. For this purpose a 0.5 per cent solution of sodium hypochlorite has been recommended. This will dissolve necrotic tissue, counteract foul odors, and allay inflammation by destroying infection. If an antiseptic is used, it should always be followed with the salt solution to prevent subsequent irritation and consequent straining. The uterus should always be thoroughly drained so as to leave only the minimum amount of fluid. It is almost impossible, however, to drain out every drop, but with the aid of cotton swabs practically all fluid can be removed.

FIG. 5.—COW RECOVERED FROM ABORTION DISEASE

This cow aborted in February and December of the year 1916, but with treatment recovered and has since dropped a normal, full-term calf and is now in first-class condition. At present she is the largest producer in a purebred herd consisting of 45 head.

If the afterbirth is not easily detachable, what should be done? The uterine cavity should be douched with several gallons of blood-warm salt solution each morning and evening until the membranes loosen and come away. The douching not only should be continued twice daily until every shred of tissue has been washed away, but also every other day thereafter until the cow comes in heat; otherwise there is danger of her becoming sterile. Moreover, this is the most successful way to stimulate early esturation (heat), to insure prompt conception, and to prevent subsequent abortions.

What is meant by vaginal douching and when should it be done? By the term "vaginal douching" is meant the flushing of the vagina. It is indicated after the mouth of the uterus has contracted so that the tube for the douche cannot be introduced and while there is a discharge. A careful stable attendant is capable of giving it if he has been properly instructed.

How should an infected bull be managed? It is a good sanitary measure to irrigate the bull's sheath before and after service according to the directions described under the section entitled "Preventive and Control Measures." This certainly will help to keep the bull from transmitting the organisms that cause the secondary infections.

When should a cow that has aborted be bred? A cow should be bred the first time she comes in heat after all evidences of vaginal discharge have disappeared. Obviously, the length of time that should elapse before breeding a cow that has aborted would vary with the individual's response to treatment and her ability to recover from the effects of abortion. Experience has shown that the earlier the cow is bred, the more likely she is to conceive.

Is it profitable to treat all cows which have aborted or show signs of harboring infection? Valuable breeding animals that fall in this class will certainly prove to be more profitable than non-infected animals that have not demonstrated their utility or developed any immunity. One reason for this statement was given in the answer to the question about the development of immunity; another reason is because experience has shown that if such animals are given proper treatment before and after conception occurs, they are quite likely to conceive normally and deliver healthy progeny.

What is the so-called "serum treatment" for abortion? The term "serum" is used very loosely by both veterinarians and farmers. By some is meant any fluid or fake remedy used for the control of abortion. Others restrict the use of the term to biologic products of different kinds. It is properly applied only to an anti-abortion serum that contains specific antibodies against abortion bacilli. Such a serum confers a passive immunity lasting only one or two months, so is not employed to any extent.

Are carbolic acid, methylene blue, and other chemical agents useful? Repeated trials of carbolic acid given by the mouth and injected under the skin have failed to support the claims made for it as a preventive or curative remedy. Nothing favorable can be said of methylene blue, which has so little germicidal action on the abortion germs that when they were immersed in a 1:4000 solution for three days they still retained vitality. Practically all veterinarians with experience regard most proprietary preparations advertised for the prevention and cure of abortion as useless or worse than useless.

Can sterility be treated successfully? Many cases respond surprisingly well to proper treatment. However, if no more than 50 per cent of those that are treated eventually become breeders, the expense is fully justified in the case of cows whose progeny have especial value. It is not profitable to expend much time and money on the ordinary grade cow or even the purebred cow that has failed to make more than an average record.

How can one determine whether a given cow would be likely to respond to treatment for sterility? A careful, intelligent examination of the internal genital organs by a competent veterinarian should reveal the exact nature of the diseased condition. Then, and then only, is he in a position to state whether it would be advisable to attempt a course of treatment or whether it would be best to send the animal to the butcher as incurable. Not only is the knowledge possessed by a veterinarian needed in a case of this kind, but also the proper instruments and skill in their manipulation. Moreover, even if it seems probable that treatment would be successful, the owner must determine whether the cow is valuable enough to warrant the cost.

When an accumulation of pus in the womb is found to be the cause of sterility, what can be done? The abnormal contents are removed by means of a special tube or catheter. Then about two gallons of a one per cent Lugol's solution are introduced to cleanse the womb. After 10 to 15 minutes this fluid is drawn off and the womb is irrigated with the warm salt solution. By massaging the womb through the walls of the rectum the fluid that has a tendency to collect on account of uterine inertia can be removed. It is best to repeat this treatment several days in succession.

How is standard Lugol's solution prepared? Five grams of iodine crystals and ten grams of potassium iodide are dissolved in 100 grams of water. This makes a transparent liquid of a deep brown color having an odor of iodine. It should be kept in a glass-stoppered bottle, protected from light, for making up the diluted solution advised above for uterine douching. The latter is prepared by mixing 1 part of the standard Lugol's solution with 400 parts of boiled water. Lugol's solution may be purchased from any druggist, if it is not convenient to prepare it at home.

What if cysts in the ovaries are determined to be the cause of sterility? In such a case the ovarian cysts should be ruptured by manipulation through the rectal walls. This is not an easy operation to perform, but an experienced veterinarian can accomplish it. When successful, it restores the functions of the cow's ovaries and results in her becoming a breeder.

If the sterile cow is pronounced incurable, or is of little value, what then? She should be sold at the first opportunity to the butcher. Under no circumstances should she be given service by the herd bull, as he might be a means of transferring the germs that were responsible for the trouble to other cows subsequently served.

DEVELOPMENT OF IMMUNITY

What is meant by the term "immunity"? The term "immunity," as it is commonly used, conveys the idea of protection against certain diseases of microbial origin. Immunity may be the result of a natural attack of disease or of purposely infecting the animal with the living, disease-producing germs. The immune animal may or may not harbor the germs in its body, but when the germs are present they are unable to produce damage.

What is understood by immunity to abortion? If a cow is immune to abortion she has the ability to resist the abortion germs. In the case of abortion immunity the protection is sufficient to prevent the most characteristic symptoms of the disease, viz., abortion of the fetus, retention of the placenta, and sterility. This does not necessarily mean that no abortion germs exist in her body or that she is incapable of transmitting them to other animals. It implies the presence of large amounts of protective substances (antibodies) which destroy or check the growth of the abortion germs.

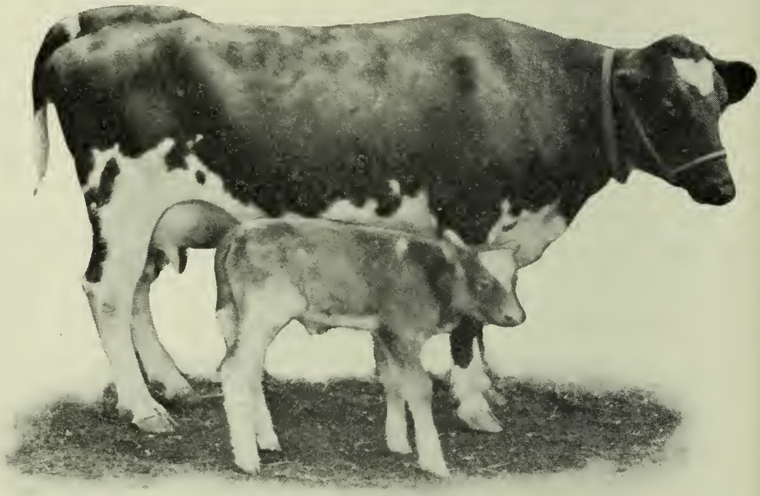


FIG. 6.—AN EXAMPLE OF GOOD MANAGEMENT

For four years this cow has been a member of a herd managed according to the methods advised in this bulletin. During this time she has not aborted or reacted to the blood tests, which is also true of the entire herd of 18 head.

How can it be shown that cows may become immune? It is a matter of common observation that cows do not continue to abort year after year, but eventually recover from the infection and bear healthy calves. About 80 per cent abort once, 15 per cent twice, and 4 per cent three times. Presumably the percentages for the latter two groups would be higher were it not for the fact that many owners dispose of aborting cows without giving them a chance to conceive again. However, this would tend to prove that protection against subsequent abortions in a certain proportion of cows is afforded by one infection that was sufficiently active to produce abortion.

Why do some herds possess more resistance than others? With the abortion disease, as with all other infectious diseases, there is naturally a marked difference in the resistive ability to disease in different herds. The reasons for this are not always clear. In some cases it seems to be due to an inherent or natural protection, the origin of which cannot be determined. In other cases it may be the care given the cattle and the means used to combat the disease. Again, the resistance may be more apparent than real, as would be the case if the herd contained a relatively large proportion of heifers, which are more liable to abort than are mature cows.

Why do all the cows in one herd suddenly stop aborting, while in another herd the cows continue to abort year after year? In the first herd it would be due to an infection with abortion germs of relatively low virulence, or to a resistance on the part of the cows somewhat higher than that possessed by the general run of cattle. In the second herd just the opposite conditions would exist. This explanation seems both logical and in accord with well-known facts concerning other germ diseases.

If a heifer aborts once, is she likely to abort in the next gestation period? If a heifer aborts her first calf there is a greater probability that she will abort during the second gestation period than a mature cow. This statement is based on carefully kept herd records. For example, of 25 heifers which aborted their first calves, 14 (56 per cent) aborted in the next season. Some heifers derive enough immunity to tide them over one or two gestation periods, but abort again in a future period.

Why do not all cows after aborting once become immune? Possibly because some of them did not get a large enough dose of the infective material to render them sufficiently resistant. In other cases it may be that the body had not time in which to produce immunity, or that some animals are not so immunizable as others.

What methods of immunization are available? There are two methods employed for conferring immunity against abortion. They are: (1) the injection of live abortion germs; (2) the injection of dead abortion germs. A preparation of the former is properly termed a "vaccine;" of the latter a "bacterin."

Why is the use of live germs urged by careful investigators? Because it is requisite, for the successful vaccination of animals against abortion, to produce a mild attack of the disease. This results in the production in the body of certain defensive substances, known as antibodies, which are capable of preventing any abortion germs that may subsequently gain entrance from producing the disease in the natural way.

By whom and on what grounds is the use of the dead germs urged? Many commercial firms engaged in the manufacture and sale of biologic products have flooded the market with "abortion bacterins." They have been the leaders in advising veterinarians and farmers to employ these products, some having gone so far as to guarantee certain results.

What results have been obtained in herds treated with both the live and the dead bacilli? Veterinary investigators for the Board of Agriculture of England have given these methods a thorough trial in herds where severe losses had occurred. A summary of their results follows:

TABLE II.—RESULTS OF IMMUNIZING CATTLE AGAINST ABORTION

	Total no. of animals	Less those which died, were barren, or were sold	Number aborted	Per cent	Number calved correctly	Per cent
Immunized with live bacilli	594	594—101=493	32	6.5	461	93.5
Controls not immunized	472	472—40=432	101	23.4	331	76.6
Immunized with dead bacilli	146	146—36=110	23	21.0	87	79.0

What do the results in the foregoing table indicate? They show (1) that immunization with live abortion bacilli (vaccination) resulted in conferring immunity on 93.5 per cent of the cattle treated in herds where over 30 per cent of them aborted before the experiments began; (2) that over 23 per cent of the untreated controls aborted; (3) that treatment with the dead bacilli conferred little if any immunity for the percentage of abortions in this group was practically the same as in the group left as controls; (4) that although the treatment with "abortion bacterins" causes little or no harm, it does not seem materially to influence the disease; (5) that the use of the live bacilli has great promise.

What are the disadvantages of employing the live bacilli? The disadvantages are: (1) rapid deterioration of the vaccine; (2) slow development of immunity; (3) temporary discomfort to the animal; (4) danger of introducing the infection.

How should abortion vaccine be administered? The method that has proved most satisfactory is the hypodermic or subcutaneous injection of the vaccine. Cattle at the Station vaccinated experimentally by injecting the vaccine into the blood aborted. The vaccine should be injected with a recently sterilized hypodermic syringe at any convenient place, preferably under the skin of the neck or just back of the shoulder. The skin over the point of injection should first be cleansed with a disinfectant.

What is the dose of this vaccine? A large dose gives the best results. At the Station 30 c. c. of a heavy suspension of the live abortion bacilli is injected. This is about equal to the amount of growth that develops on the surface of hard media 2 by 6 inches in area.

How long does the immunity produced by injecting live germs last? The length of time a cow is rendered immune varies with the individual animal. Experiments conducted at the Wisconsin Station prove that in cases treated with living germs the protection was effective for two years, throughout two gestation periods, and probably for a longer time. The English Commission state that it is necessary to continue the inoculations for a time on the infected animals after abortions cease to occur. Any animals brought from other herds should be inoculated at the first opportunity. In England very few of the animals that have been immunized for one pregnancy have aborted subsequently; therefore, it appears that if an animal is immunized for two pregnancies there is very little chance of her aborting afterwards. It is important for the dairyman to know that the use of live abortion bacilli (contagious abortion vaccine) does not cure or eliminate the germs from the treated animal, but simply puts it in condition more effectively to resist the attacks of the germs.

When is the proper time to vaccinate? A vaccine is a preparation containing the living germs and can be safely used only on unbred heifers and open cows at least two months before being bred. If animals are treated during pregnancy there is danger of causing abortion.

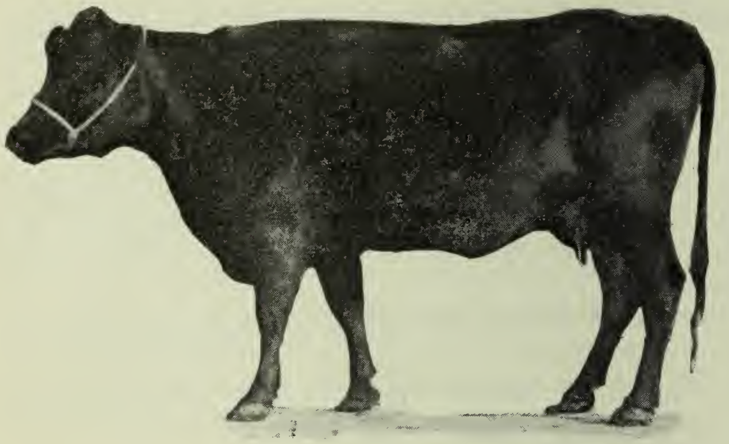


FIG. 7.—AN EXAMPLE OF POOR MANAGEMENT

A member of a herd in which little effort was made to control the abortion disease. She has aborted twice and still reacts strongly to the blood tests. Two-thirds of the cows in the herd have the disease.

Is this method of treatment recommended for general use? The results given above are highly encouraging. However, its general use is not advised until more evidence is gathered from cattle that have already been treated in Wisconsin. The University will gladly cooperate with reliable breeders who have valuable herds that they wish to immunize. Correspondence is invited with owners who are interested in this proposition. Letters should be addressed to the Department of Veterinary Science, College of Agriculture, Madison.

What effect does injecting the live or dead abortion germs have on the blood test for abortion? Such injections cause the blood of the treated animals to react to the tests. In the case of most animals it has been found that the blood gradually loses its reacting property unless the injections are repeated from time to time. Blood tests on herds that have been treated with a vaccine or bacterin are helpful in determining the degree of immunity that the animal possesses.

What are the reasons for bulls showing a greater resistance against abortion than heifers and cows? Bulls appear to have a sexual immunity that is accountable for their being less susceptible. This appears to be due to certain anatomic and physiologic differences in their sexual organs which make these less favorable places for the growth of the abortion germs than those of the opposite sex.

PREVENTIVE AND CONTROL MEASURES

How can abortion be prevented from getting a foothold in a clean herd? Eternal vigilance by the cattle owner to prevent the introduction of infection is the first essential to success in any attempt to keep a herd free from abortion. This implies the maintenance of a sanitary stable and provision for an adequate supply of suitable feed. In order to detect cases of abortion infection before the animals actually abort, the herd should be tested once or twice a year and all reacting animals removed at once. When it is desirable to purchase stock to build up the herd, preference should be given to calves under ten months of age as they are less apt to be infected at the time of purchase than are heifers or cows. All cows from the outside must be required to pass a blood test before being turned with the herd.

What can be done to control abortion after it breaks out in a herd? The following procedure is recommended in handling a herd of cattle in which abortion infection is known to exist: (1) daily douching with the salt solution of all cows that have a vaginal discharge; (2) provision for a food supply that is adequate as to nutritive and mineral content and free from contamination; (3) complete removal of retained afterbirths with subsequent cleansing of the womb as previously described to prevent an accumulation of pus which is likely to result in sterility; (4) disposal of aborted fetuses and contaminated bedding by burning or deep burying, and disinfection of the gutters and floor; (5) isolation of all cows known to be infected with abortion; (6) when possible, treatment of all heifers and cows about two months before breeding with a vaccine composed of live abortion germs.

Are these plans successful? The Station has been able to prevent and control contagious abortion in both non-infected and infected herds when the appropriate plan was conscientiously followed. The owners praise the results obtained and feel that at last satisfactory systems of managing purebred herds have been found. It should be understood, however, that although excellent results have been secured in a few herds, many more must be kept under the conditions specified before it is safe to conclude that these plans will be generally successful. Dairymen should familiarize themselves with the methods of procedure so that they can put one plan or the other into operation on short notice. It would be unreasonable even to hope that every abortion could be prevented, but there is assurance that the disease may be effectively controlled if the proper plan is followed.

What are the most important factors in the control of metritis, abortion, and sterility? Experience teaches that thorough cleansing of the genital tract after an afterbirth has been retained is the key to success in preventing and controlling these diseases of the cow's generative organs. For this purpose a solution of common salt in water, prepared and introduced according to the directions given, is best. This solution is preferable to a disinfectant which is certain to cause irritation and straining if it is made strong enough to kill germs. Another factor in controlling these diseases is to keep healthy cows from coming in contact with the discharges of infected cattle.

May the herd bull be allowed to serve cows from other herds? Not unless the herds are known to be free from the abortion disease and are being maintained under the system recommended in this bulletin. Even then the bull's sheath should be flushed out before and after each service with the weak Lugol's solution that has been recommended for the irrigation of cows.

What is the best method of irrigating the bull's sheath? A soft rubber tube attached to a funnel or regular hospital irrigator is greased with vaseline and gently pushed into the sheath. The hand is used to compress the sheath about the tube so that every fold in the former may come in contact with the fluid. After a minute the hand is released to permit the fluid to escape; then the process is repeated. Lugol's solution of iodine diluted to make a 0.25 per cent solution and prepared according to the directions already given is one of the best antiseptics for this purpose.

Is it necessary to douche or irrigate the genital organs of healthy animals to prevent abortion? Douching of healthy cattle is not only unnecessary but is also likely to be harmful if long continued. Furthermore, unless great care is used there is danger of disseminating disease by the rubber tube or syringe. For these reasons, it is not advisable to irrigate healthy cows, heifers, and bulls.

Is it advisable to change bulls to prevent further trouble from the abortion disease? Many farmers, thinking that the abortion disease is due to the herd bull, have disposed of him and bought another only to find that the trouble continued or became more severe. From the facts presented elsewhere in this circular about the bull's part in abortion, it is clear that by getting another to head the herd the problem of controlling the abortion disease will not be solved.

Is it possible to eradicate the abortion disease by selling all cows that abort and buying others? This would depend on the extent of the disease in the home herd and the herd from which the new cattle were obtained. Ordinarily it is not good policy to sell cows that abort as this depletes the herd too much. Furthermore, if the aborting cow is given the attention advised, she is a more valuable member of the herd than cows from other herds about which little or nothing is known. On the other hand, if only one cow aborts it is good policy to dispose of her at once before she has had an opportunity to infect other members of the herd.

What precautions should be taken before bringing cattle into a herd that is free from the abortion disease? All cattle that are to be placed in an abortion-free herd should be quarantined until after calving and required to pass at least one blood test. Otherwise there is danger of introducing the disease.

Should every animal responding to the blood tests be sold? Reference should be made to the answers to questions under ''Treatment of Affected Cattle.'' As a general proposition, if only a few animals react, it would be feasible to dispose of them, but if 10 per cent or more of the herd react it would not be good policy.

How long will it take to eradicate the abortion disease from a herd? While it may be impossible completely to eradicate the abortion disease from a herd in one year or even two, there is no doubt that the disease can be controlled and the herd made profitable if the directions given herein are followed with intelligence and persistence.

Would it be safe to bring a calf from an infected into a clean herd? If the calf has been fed pasteurized milk for a period of three or four weeks prior to moving, or has been on a ration that does not include raw milk for a like period, there is little chance of its bringing the disease into a clean herd. Otherwise, it should be kept in quarantine at its new home for a month before being permitted to mingle with the other stock.

How may a stable be disinfected? All loose litter should be removed from the floor, mangers, and watering troughs. Then the entire inside of the stable, including the ceiling, should be swept and scrubbed to remove all encrusted material. Afterward a reliable commercial coal tar disinfectant, prepared strictly according to the manufacturer's directions on the original package is to be applied. Keep in mind the fact that sunlight and air are effective destroyers of germ life and admit them to the stable at every opportunity. Whitewashing the interior of the stable is also helpful. A sprinkling of air-slaked lime over the floors and in the gutters helps to keep the stable sweet and aids in disinfecting it.

Is there a law against selling cattle infected with abortion? There is no law that prohibits the sale of abortion-infected cattle for slaughter. If such cattle are sold to go into other herds the seller should inform the buyer that abortion exists, else he may be held for damages resulting from abortion infection.

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Wisconsin Bulletin 297 September, 1918

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Hairless Pigs
The Cause and Remedy

E. B. HART AND H. STEENBOCK

PROPER TREATMENT PREVENTED HAIRLESS MALADY

This sow had previously produced a litter of dead and hairless pigs. (See Fig. 2) She was again fed on the same ration,—33 parts of corn, 33 parts of oats, and 33 of clover,—but when to this was added 10 grams of potassium iodide to each 100 pounds of feed she produced a normal litter.

AGRICULTURAL EXPERIMENT STATION
OF THE UNIVERSITY OF WISCONSIN

MADISON.

DIGEST

An increasing number of hairless pigs is born annually in the hog belt. This malady has caused heavy losses in several states and has appeared in Wisconsin. Page 3.

Goiter is the cause of the hairless pig malady. The thyroid gland is enlarged and fails to work properly. The enlarged gland is not so noticeable in the sow as in the pigs. It does not affect the health of the sow, but does interfere with her powers of reproduction. Pages 3–6.

A small amount of iodine in the feed prevents hairless pigs. Ten grams of potassium iodide in 100 pounds of feed for the sow prevents reouble. Pages 6–8.

It is impossible to tell whether or not a sow has goiter. Where hairless pigs are born one year it is safe to use the iodine remedy the next year. The malady occurs more often with spring pigs. Pages 7–9.

A proper ration may do much to prevent hairless pigs. Plenty of roughage—alfalfa and clover hay—helps. The Wisconsin outbreak in 1918 was probably due to feeding too much grain and too little roughage. Pages 9–10.

Feed a small amount of potassium iodide and increase the roughage for the breeding stock on farms where hairless pigs were born the past year. Pages 10–11.

Hairless Pigs

The Cause and Remedy

Every spring on the farms of Wisconsin as well as in other sections of the "hog belt" there is born a considerable number of hairless pigs. Practically every county where swine raising is developed and from which we have had reports has had cases of this malady. It occurs in the northern as well as in the southern counties, and in the western as well as in the eastern part of this state.

In some other sections of our country, notably in Montana, the losses from hairless pigs have been enormous. It is estimated that from 100,000 to 1,000,000 are lost annually in that state alone from this cause, and it has become a serious menace to the swine industry in several states and to some of the swine breeders in our own state.

Hairless pigs are of normal weight and size, perhaps a little above normal weight; they are generally carried the full gestation period and often four to seven days over time. When absolutely hairless and born alive they may live a few hours after birth, but always die sooner or later. They are characterized by thick pulpy necks, thick skin, no squeal, and no vitality. Where perfectly hairless the skin is smooth, shiny, and bald, except for a few hairs around the eyes and nose. The hoofs of hairless pigs are thin-walled and undeveloped. In the same litter there may be variations from pigs with full-haired coats and full vigor to pigs with scanty-haired coats and little vitality. Those with some hair may live if given special attention and care.

Pigs in this condition are more likely to be born from gilts than from old sows. They are more likely to be born in the spring than in the fall.

GOITER IS THE CAUSE

The cause of this malady in both sow and young pig is goiter, an enlarged, improperly working thyroid gland. The thyroid gland, at the center and base of the throat in its enlarged condition accounts for the thick necks of the little pigs. The sow is also suffering from an enlarged thyroid, but this cannot be so readily observed due to the large, fat, fleshy neck. The goiter in the sow does not seriously affect her health and it does not affect her use for meat, but unless corrected it does interfere with her breeding functions. The thyroid gland of a normal new-born pig is about the size of a pea, while that of a hairless pig is the size of a hickory nut. The gland in a normal sow varies in size, but usually is not larger than a walnut, while in a sow producing hairless pigs it is the size of a man's fist.

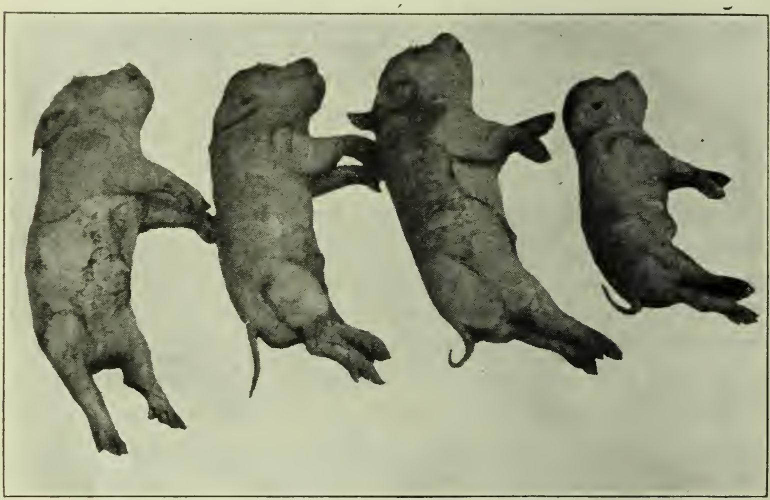

FIG. 1.—A GROUP OF HAIRLESS PIGS

Hairless pigs are dead pigs. The losses from the production of hairless pigs in Wisconsin have been considerable and most of them can be avoided.

Studies of goiter in the human race have shown that when the thyroid gland is removed or its function interfered with, as in goiter or in cancer of the thyroid, the hair and nails cease to develop and the skin of the face and neck becomes thick and pulpy. These conditions correspond very closely with those found in hairless pigs.

The immediate cause of goiter in the human race is not clearly established by medical science, but a cure for the simple form has been found in the use of iodine. It is surprising how widely prevalent goiter really is. It is estimated that

85 per cent of the dogs on the streets of Chicago show more or less enlargement of the thyroid; and goiter or "big neck" is being recognized more frequently in calves, lambs and colts. In the states of Oregon, Washington, and Montana considerable losses by big neck in colts, lambs, and calves have been reported and cases among lambs have been reported in our own state. At one time the sheep-raising industry of Michigan was in danger, because of goiter in lambs. Before the discovery of salt deposits around the Great Lakes its future seemed hopeless, but with the development of the salt industry and the use of salt by sheep growers goiter rapidly decreased. The salt contained appreciable quantities of iodine. At present the refined rock salts coming from Michigan, as well as from other parts of the United States, do not contain enough iodine to make their use a guarantee of goiter prevention.

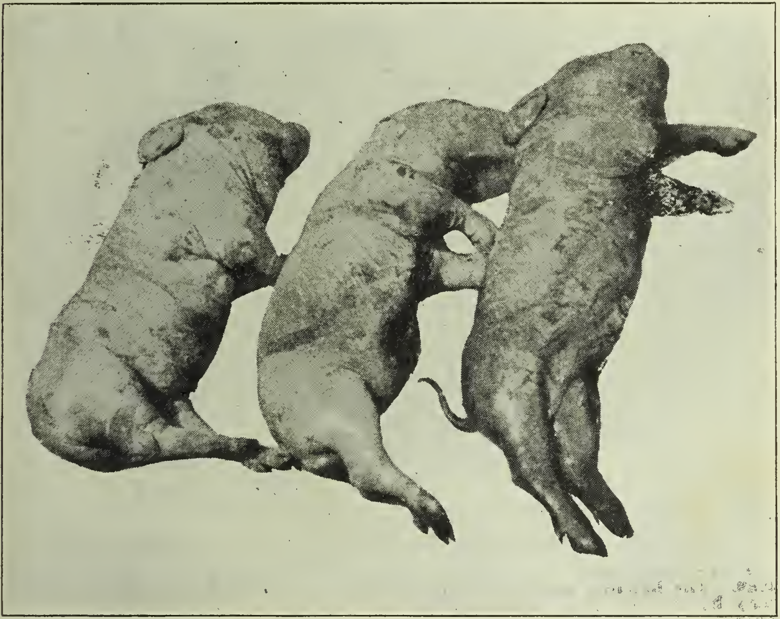

FIG. 2.—DEAD HAIRLESS PIGS

Note the thick necks indicating a goitrous condition. The mother of these pigs had been started on a grain ration—high protein and no roughage. On this ration she did not thrive well and was changed to one consisting of 15 parts of alfalfa, 25 of corn, 25 of oats, 25 of middlings, and 10 of oil meal, and kept under strict confinement. She had produced two litters of hairless pigs on this ration before being changed to the ration of 33 parts of clover, 33 of corn and 33 of oats on which she again produced hairless pigs. The picture on the cover shows how the trouble was corrected in this same sow by the use of potassium iodide.

Marine, a few years ago, found goiter prevalent among brook trout artificially reared in hatcheries, while those in the free runs outside of the ponds did not have this trouble. He was able to prevent the disease in several hatcheries by the use of very small amounts of tincture of iodine added to the water.

USE OF IODINE PREVENTS HAIRLESS CONDITION

The fact that hairless pigs are the product of a mother suffering from goiter suggested the possibility of curing and controlling this malady with iodine. The thyroid gland forms a chemical substance containing iodine which it circulates through the blood stream. This compound is of the greatest importance to the proper development of an animal. When conditions arise requiring more of this compound, and the iodine supply in the food is not increased, the gland enlarges to let more blood pass through it in a given time. It is, therefore, either a failure to absorb the iodine from the feed or a failure of the thyroid gland to absorb the iodine that is in the blood that causes goiter.

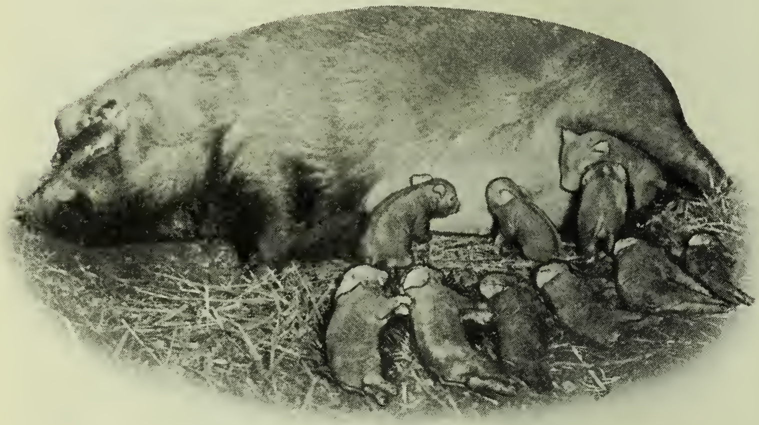

FIG. 3.—A MIXED LITTER OF HAIRED AND HAIRLESS PIGS

A sow may produce a litter in which there are both haired and hairless pigs. The hairless ones are dead, while those with hair will show life and may be raised. This sow grew up on a ration of 30 parts of corn, 30 of oats, 30 of middlings, 8 of oil meal and 1 of tankage. She was under strictly confined conditions, but appeared normal in every other respect, excepting in reproduction.

The thyroid gland of the hairless pig contains no iodine; a normal thyroid in its dried state contains about .2 per cent of iodine. The iodine supply in our feeding materials is comparatively low and this is true for all feeding materials. However, in most instances there is enough iodine present in our feeds when it is *properly assimilated;* but under certain conditions of life, the exact analysis of which is not possible in the present state of our knowledge, our farm animals are unable to absorb sufficient amounts of iodine.

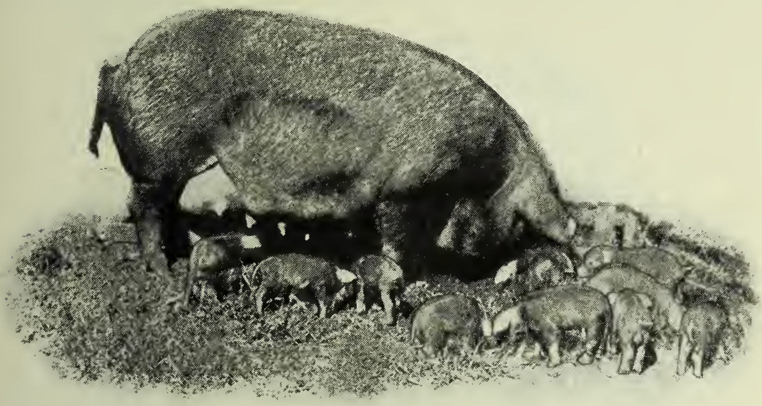

FIG. 4.—ANOTHER CORRECTION WITH POTASSIUM IODIDE

The same sow as shown in Figure 3 and on the same ration, but to which was added 10 grams of potassium iodide to each 100 pounds of feed. All the young were born alive and in normal condition.

HOW TO USE IODINE

We have successfully corrected the hairless pig trouble by giving the sow during her entire gestation period 10 **grams** (approximately ⅓ of an **ounce**) of potassium iodide per 100 **pounds** of feed. This material can be procured from almost any drug store. It should be powdered to a meal as fine as flour, and then mixed with 100 pounds of feed.

There is no way, so far as we know, of telling beforehand whether or not a sow has goiter. But where hairless pigs have occurred on the farm it would be good insurance against their reoccurrence to use potassium iodide. At the present prices for this chemical a sow can be carried through the entire gestation period for about 25 cents. Special quack remedies should be avoided; nothing but iodine will do the work and the products of venders of special drugs should be avoided. **This malady is not abortion, but is due to the poor working of the thyroid gland.**

Tests of this treatment at the Montana Experiment Station have shown that about half of the amount of potassium iodide we have used, when fed for 60 days, will prevent hairless pig production. We have not as yet had an opportunity to try the smaller dose, but would recommend that from 5 to 10 grams of potassium iodide (1/3 to 1/6 of an ounce) per 100 pounds of feed be used. Do not use more as it would be unnecessary and a waste of money. It had better be fed the entire gestation period, or at least the last 75 days of gestation, until further experiments have decided whether a shorter period of use would be equally efficient.

VARIATIONS IN THE MALADY

This malady is subject to the greatest variations. Four sows in the same pen and fed the same ration and cared for in identically the same way may give the following results: two will come through with sound, normal litters; the third will give a mixed litter, that is, some with a good hair coat and some with scanty hair coat, or absolutely hairless; the fourth will give all hairless pigs. We believe these results are probably due to constitutional differences in the animals, inherent factors which always display themselves with any group of animals. A ration that is near the border line of deficiency in iodine and at the same time is slightly out of balance in some other respect may well affect some individuals more than others.

Again, a farmer may lose 90 per cent of his spring pigs by this malady and yet that same breeding stock may produce under summer conditions, such as pasture and exercise, good litters in the fall. It is such conditions as summer pasture and exercise that are important factors in preventing this malady without the use of potassium iodide.

PROPER REARING MAY PREVENT HAIRLESS PIGS

We have reared a considerable number of sows on rations made partly of grains, but with 25 per cent of alfalfa in the ration and under these conditions have never had a case of hairless pigs. They were even confined in pens while on these rations. But when our young stock was started at weaning time on concentrates such as grains and skimmilk, and little or no roughage was used in the ration, hairless pigs often resulted; and there was just as much iodine in one ration as in the other.

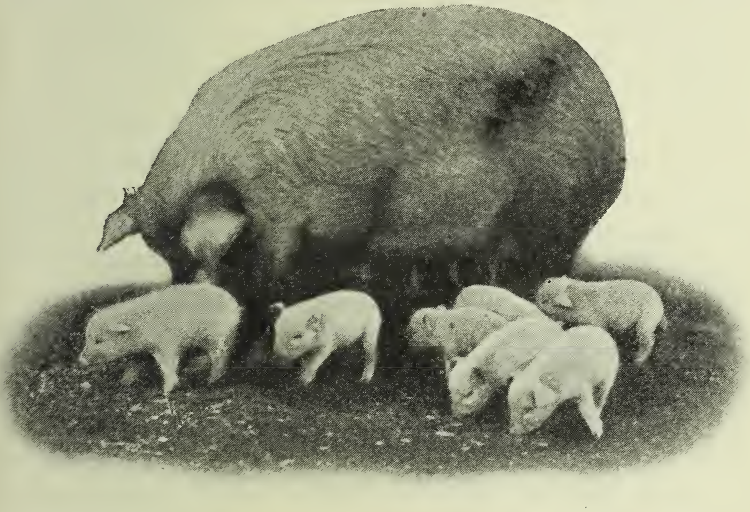

FIG. 5.—RAISING THE GILT SO AS TO HELP IN THE PREVENTION OF HAIRLESS PIGS

We believe that hairless pig production is often the result of improper feeding of young sows, such as giving them too high protein feeds and too little roughage in the ration. This sow was reared on a ration of 75 parts of corn and 25 of alfalfa. While the sows may grow at a somewhat slower rate than normal, yet the litters have always been haired and strong where sows have been reared on rations containing 15 to 25 per cent of roughage.

Alfalfa or clover hay should form 25 per cent of the ration. If choice, leafy hay is fed in a rack, sows will (usually) eat this proportion of hay. However, if they do not eat enough of the uncut hay to make about 25 per cent of the ration, the hay may be cut and mixed with the other feed.

An extraordinary outbreak of hairless pigs occurred in the spring of 1917 in areas in Montana not previously affected.

There had been a cold, long winter, roughage was scarce, and the animals were wintered mainly on grains. In the spring of 1918, after a mild winter, with practically no snow, and plenty of hay, there were almost no cases of hairless pigs in the "unaffected" areas.

In Wisconsin, the spring of 1918 saw some of our breeders experiencing this malady for the first time. The winter had been extremely severe and roughages were scarce among those suffering most. Our experience indicates that the liberal use of roughage and the feeding of rations not excessively high in protein are by far the safest rules to follow in the rearing of gilts for breeding purposes, if the too common occurrence of hairless pigs is to be prevented. Farmers should not rely wholly on grains and skimmilk for their breeding gilts. Introduce 25 per cent of the ration as cut alfalfa or clover. This gives bulk to the ration and insures proper elimination of waste through the intestines; it keeps the intestines in a healthy condition and will allow the absorption of sufficient amounts of iodine naturally present in the feed to meet the sow's needs without the use of potassium iodide. Keep the animals dry and provide exercise. Goiter is more prevalent in northern, mountainous districts with cold, long, damp winters and little sunshine, than in the warm climates with plenty of sunshine and opportunity for exercise.

The suggested method of rearing breeding swine may not always prevent goiter—some cases will need the potassium iodide treatment—but we believe proper rearing will go a long way toward solving a growing difficulty in this state. However, if you had hairless pigs in the spring of 1918 it will be advisable to use the potassium iodide treatment this winter.

SUMMARY

Goiter, or an enlarged thyroid gland the function of which is disturbed, is the cause of hairless pigs. Both sow and young are afflicted with enlarged glands.

The enlarged glands are deficient in iodine, which is essential to the proper action of this gland and the production of normal young.

Iodine, supplied the female breeding stock during the gestation period, will prevent this trouble. One-third to one-sixth of an ounce of potassium iodide to each 100 pounds of feed will prevent hairless pigs. Do not use more.

Rearing the breeding sows with plenty (25 per cent) of good roughage, such as alfalfa or clover hay, in the ration and not an excessive amount of protein may do much toward preventing this trouble and thus avoid the necessity for using the potassium iodide treatment later.

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Bulletin 298 March, 1919

Prune the Cherry Trees

R. H. ROBERTS

WELL PRUNED TREES MEAN MORE CHERRIES

Wisconsin cherry orchards are already profitable, but larger and surer yields are possible when the trees are properly pruned.

AGRICULTURAL EXPERIMENT STATION
OF THE UNIVERSITY OF WISCONSIN

MADISON

DIGEST

Heavy pruning of the top at planting is one of the elements of success in securing a good growth the first season. Page 3.

The time to prune seems to be of relatively little importance. Page 4.

The young trees need careful pruning to secure strong heads and well spread branches. Pages 4–5.

A "modified-leader" tree is better than an "open center" tree. It has a stronger head, is more spreading and is lower. Page 7.

Heading back or "tipping" depends upon the growth being made. Page 8.

Weak crotches can be largely prevented by unequal heading back of equal sized branches. Page 10.

The formation of blossom buds is related to amount of growth made. Pages 12–14.

Spur blossom buds are hardier than the blossom buds along the short branches. Page 15.

Early bearing is often undesirable. Keep up the growth of the tree and develop a spur fruiting system in the young tree. Pages 17–18.

The amount of fruiting area is but little affected by the type of pruning. The kind of fruiting area is greatly affected by the pruning. Pages 19–20.

A maximum bearing area is developed by rather young trees. This is usually far in excess of the fruit developed. Pages 21–23.

Low, open trees are best—How to grow them. Pages 25–26.

Rejuvenation pruning is seldom satisfactory. Page 28.

Pruning is only one means of keeping up strong growth of the trees. Soil fertility and cultivation are other means. Use pruning to keep the tops open and other cultural practices to maintain the growth. Page 29.

Prune the Cherry Trees

Pruning helps in at least four ways to make cherry growing more profitable. It keeps up the bearing area of the trees, reduces winter-killing of the blossom buds, cheapens production by making lower trees, and lengthens the life of the trees because of the stronger tree heads formed.

The orchard investment pays best when large, regular and cheap crops are secured through a long term of years. Regular pruning of the right kind helps to give these profitable results for the sour cherry.

Wisconsin has become during the last few years one of the principal cherry producing states. Pruning has played an important part in the successful development of the cherry industry. Observations made on Early Richmond and Montmorency trees during the last three years, as well as the experiences of the most successful growers of Michigan and Wisconsin, show that the sour cherry tree thrives best when regularly, and often heavily, pruned. This is contrary to the frequent advice that the cherry tree should be pruned little, if any. These varieties need as much or more pruning than is usually given apple trees of the same ages.

PRUNE HEAVILY AT PLANTING TIME

Setting the tree firmly so that the roots are in close contact with the soil is of more value in getting it to live and start well than is careful root pruning. Most of the roots of the tree, especially the feeding roots, are left in the ground when the tree is dug. The usual rule is to cut off crowding and broken roots and shorten those which are over 10 inches in length. Because of the loss of roots at digging and the later root pruning, a like reduction in the amount of top is needed to insure strong, new top growth under average soil conditions. This means heavy pruning of the top at planting time. (Fig. 1.)

Some growers choose the four or five main branches at this time, removing all others. Although all very weak growths should be cut off, it seems best to wait until after one season's growth has been made to choose the main branches. Fewer mistakes in selecting them will be made then, and little or no harm will have come from having left a moderate excess of branches.

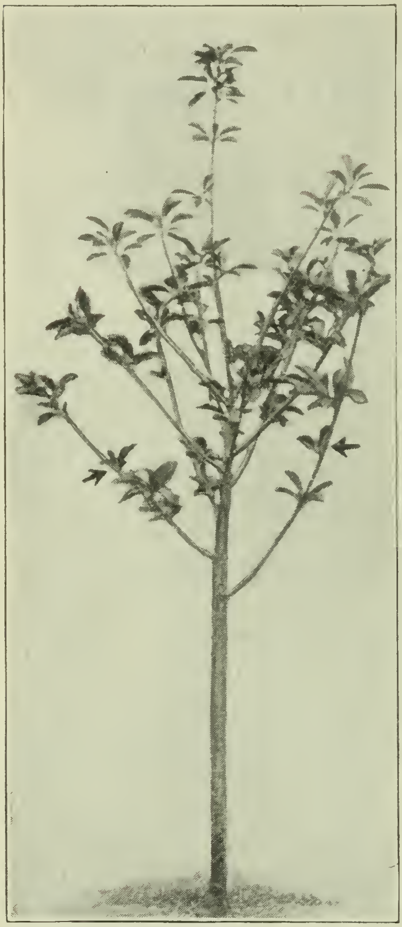

FIG. 1.—CUT THE TREES BACK HEAVILY AT THE TIME OF PLANTING

Trees with too much top seldom start well. They merely "feather out" the first season. Cut off all but the leader and four to six of the best branches. Cut the branches back to two or three strong buds, as shown by the arrows. Leave the leader three to four inches longer than the branches.

As cherry trees often have few buds left after packing and shipping, definite rules as to the amount to head back cannot be given. If plenty of buds are present, six to nine or ten inches is a good length to leave the branches. At least two good buds should be left on each branch. (Fig. 1.)

PRUNE AFTER THE SPRING THAW

Probably the best time to prune is after the spring thaw. It is much better to prune in the late fall or early winter, if labor is available then, than to fail to get the pruning done.

PRUNE THE YOUNG TREE CAREFULLY

The young tree should be pruned each year. The time to start it low, keep it free from weak crotches, and develop a good form is while it is young.

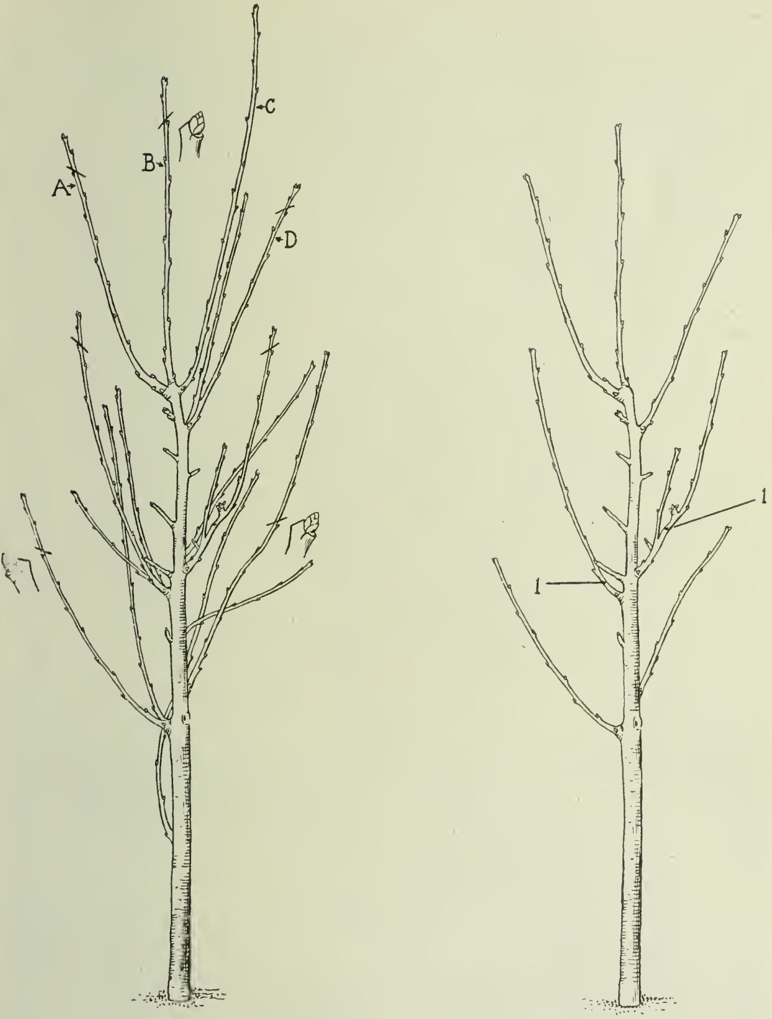

FIG. 2.—PRUNING ONE YEAR FROM PLANTING

This tree was cut back heavily at planting. The photograph shows it before and after pruning. It made a strong growth. Any one of the branches, A, B, C, or D, could be used as a leader.

LOW HEADED TREES ARE BEST

The development of orchard cultivators has made it unnecessary to grow high-headed trees. Ease of harvesting and spraying has made the low tree generally popular. About 18 to 24 inches is the favored height of the lowest main branch.

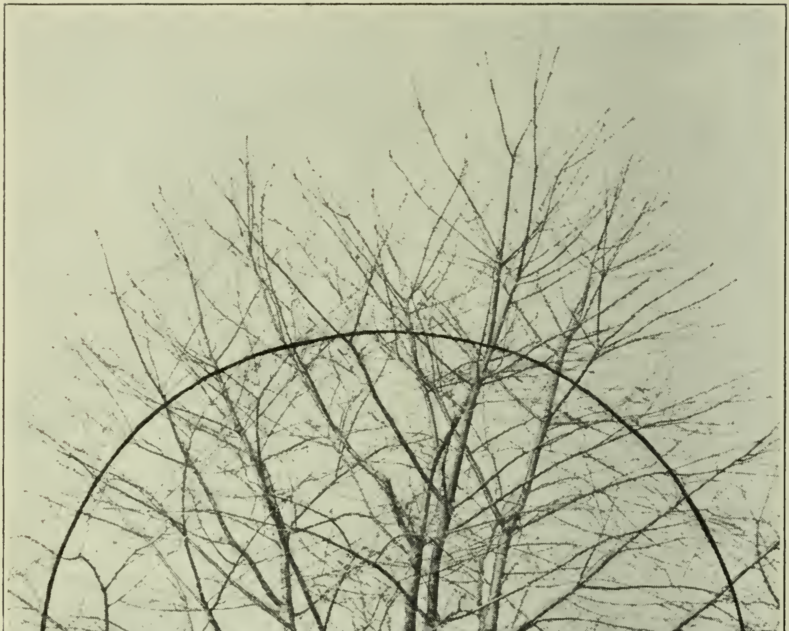

FIG. 3.—"OPEN CENTER" TREES ARE SUBJECT TO WEAK HEADS AND DENSE TOPS

This nine-year Richmond grew tall too fast, principally because it had but few main branches and was pruned little. Most of the low wood has been outgrown and is dying. Most of the crop is outside of the mark indicated. Heading back is becoming necessary. If cut back far enough to give a tree of good height, most of the fruiting wood is gone for one season. Keep the trees low when younger.

GROW A "MODIFIED-LEADER" TREE

Try to avoid weak crotches when starting the young tree. Because it is likely to break down after coming into fruiting, the so-called "open center" type of tree (Fig. 3) has been largely dropped from Wisconsin orchard practice.

The open center tree is formed by cutting out the leader or most upright branch at planting time. This leaves an opening in the center around which the main branches are spaced.

A leader or "modified leader" form of tree has come into favor in place of the open center tree. (Figs. 4, 5.) This tree is grown with a leader for two or three seasons. At this time the leader is suppressed or modified by being cut back to a lateral branch of the last season's growth. (Fig. 8.)

The growers who were most careful to start open center trees found that their trees were not only weak and likely to split, but also that the tops of the bearing trees were not open. The openness of the top is not so much due to the pruning given the newly planted tree as it is to the pruning done each season when the tree is older. In fact, open center trees which are not pruned regularly, are more subject to dense centers than are modified leader trees.

The branches of trees grow toward the light. When the central branch is cut out at the time the tree is set to form an open center tree, there is better light in the center of the tree than at the sides. This permits the main branches to grow straight up and close together. (Fig. 3.) On the other hand, the shading done by the leader in the other form of tree, causes the main branches to grow in a more spreading direction. (Fig. 4.)

TRAIN THE TREE THE FIRST YEAR AFTER PLANTING

Begin to train the tree one year after planting. There are four important things to do: (1) Select the main branches, leaving a leader; (2) remove cross and crowding branches; (3) keep the top balanced or equal sided; (4) do necessary heading back. (Fig. 2.)

GROW A TREE WITH MANY BRANCHES

Fully grown trees with seven to nine main branches and few laterals are better than those with only four or five main branches and more laterals. They have a better spur habit and it is easier to harvest the fruit from them. (Fig. 4.) Trees with few main branches grow tall too quickly, owing to too much terminal growth of these few branches. (Fig. 3.)

The number to leave the first year depends largely upon their position and the amount of growth being made. Only strong, well-placed branches which are making a good growth should be left. If possible, have them well spaced around the leader, a good distance apart and growing at a wide angle with the tree trunk or leader. Do not try to use weak growths as the main branches of the tree. Four or five may be left the first year and the remainder selected a year or two later from others arising from the leader.

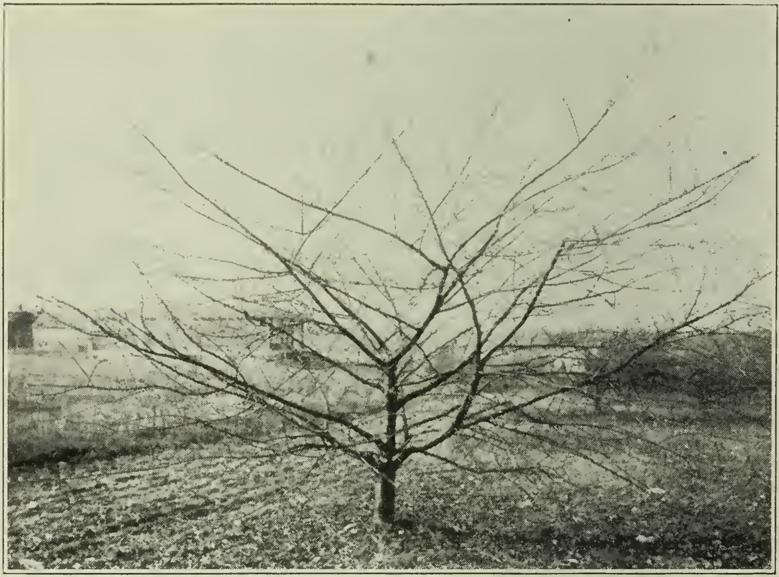

FIG. 4.—THE LOW SPREADING TREE HAS MANY FRUIT SPURS

Modified leader trees with many branches are best. The low branches are not outgrown by the top ones. The top is comparatively shallow and because of less shading the spurs live longer. Picking is easier.

HEAD BACK AS NEEDED

Heading back, or "tipping," of the new growth to increase the number of branches, as practiced with the apple, is seldom needed with the cherry, owing to its habit of freely producing lateral branches. When the seasonal growth is long (from 20 to 24 inches or more) tipping is needed to prevent the growth

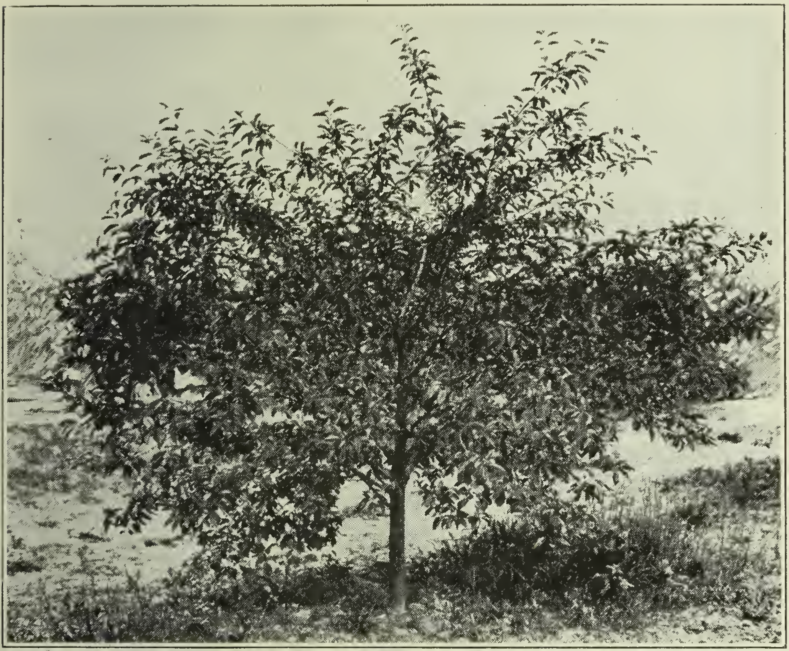

FIG. 5.—GROW A MODIFIED LEADER TREE

A young Richmond one year after suppressing the leader. It has a strong head, it is more spreading and it has a better fruiting habit. Many branches of about equal growth and size give the best tree.

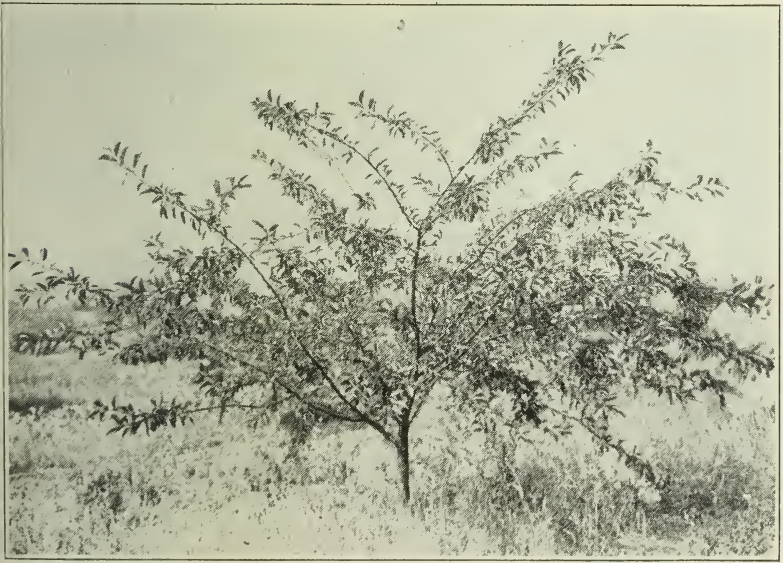

FIG. 6.—HEAD BACK THE BRANCHES TO PREVENT SLENDER GROWTH

A low open top does not mean a thin top. Leggy, willowy branches should be headed back. Heading also increases their number. Stocky branches do not whip about with the wind and injure the fruit.

of long willowy branches (Fig. 6) or too great height of the trees. From 16 to 20 inches is a good length at which to head back. Growths shorter than this need no tipping unless it is done to increase the number of branches. It is not desirable to cut the branches shorter than about 16 inches.

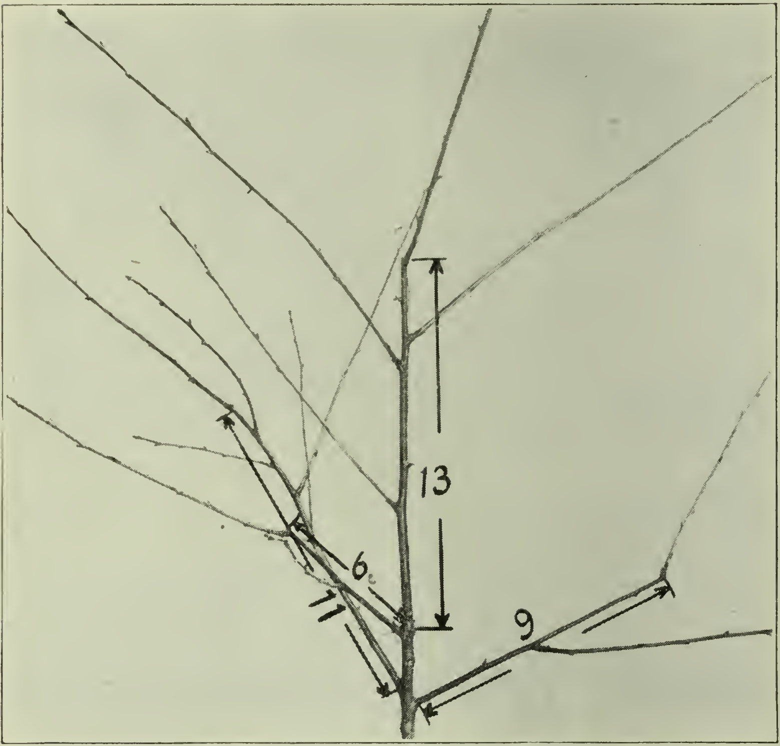

FIG. 7.—BRANCHES OF DIFFERENT LENGTHS MAKE DIFFERENT AMOUNTS OF GROWTH

Unequal cutting back results in unequal growth. This prevents weak crotches. Compare the thickness of the branches with the lengths at which they are cut back.

HEAD BACK TO PREVENT CROTCHES

The main use of tipping of the young cherry trees is to prevent the branches being weak-crotched. When two or more branches grow out close together, the one cut back the least will make the greatest terminal growth the next season. (Fig. 7.) A difference of three or four inches in length is enough to cause unequal growth and thus prevent limbs of equal size with weak crotches. The formation of a weak crotch may result wherever two branches come out together.

The principle of equal growth of equal length branches which grow out together, explains the weakness of the open center tree in which equal heading-back of the branches gives equal growth and a weak-crotched tree head. In the case of modified leader trees, the leader should be left three or four inches longer than the side branches. (Fig. 2.)

CONTINUE THE TRAINING THE SECOND YEAR

The pruning done the second and third years after planting and probably the fourth year, will be about the same as for the first year after planting—taking out excess and crowding wood, selecting new foundation branches as needed, and checking the formation of crotches by unequal heading-back of forked growths. Less tipping will be done after the tree becomes older, especially when the annual growth becomes less than 18 inches.

The leader may be suppressed either the second or third season, preferably the third. (Fig. 8.) This is done by cutting the last season's growth of the leader back to a lateral branch. Care must be taken to avoid having two top branches of equal length or a weak crotch will be formed at this point.

PRUNE THE BEARING TREE FOR FRUIT

Securing proper form is largely the object in pruning the tree until it is four or five years of age. After that time, the chief aim of the pruner should be to develop and maintain the fruiting wood of the tree; that is, to aid spur development and especially to try to keep the fruit spurs alive on the lower wood where economical harvesting is possible.

Too much pruning is done for the one purpose of removing dead wood. The dead wood is largely due to shading. This loss of low wood should be prevented by doing the pruning to keep the top open earlier in the life of the tree.

An open-topped tree is not one with a hollow top or a so-called vase form of tree, but rather a tree of average form which is kept open by thinning out, so there is little shading as compared to the heavy shade in dense bushy trees. (Fig. 11.) It is, however, best to have a low, spreading form of tree, as this permits the greatest access of light to a large fruiting area and yields the best crops of fruit. (Fig 12.)

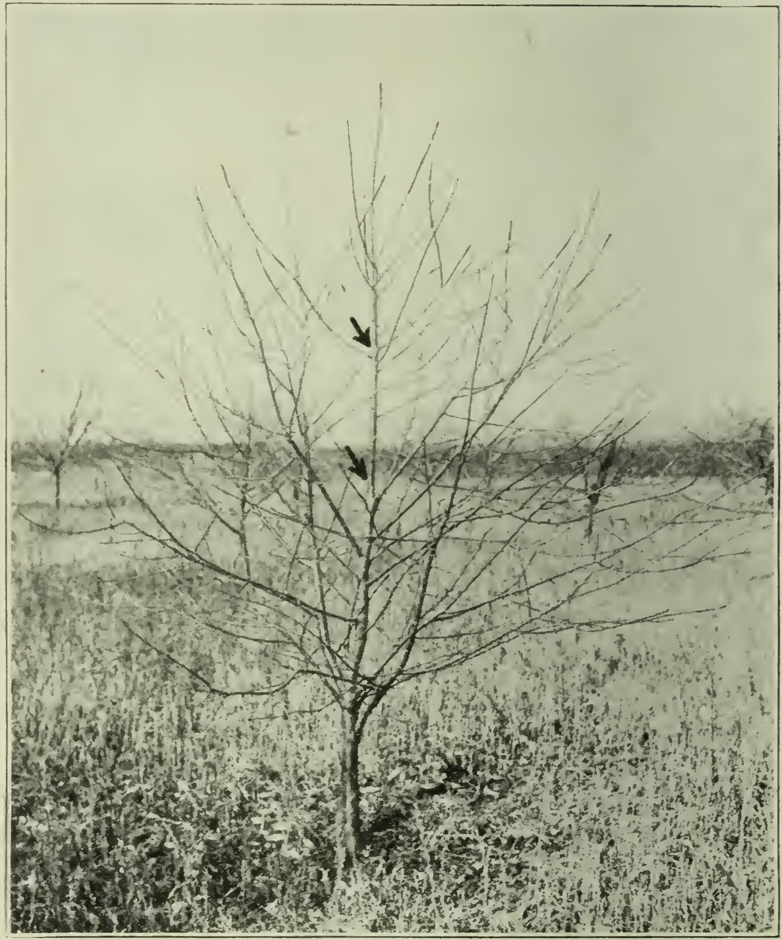

FIG. 8.—SUPPRESS THE LEADER THE SECOND OR THIRD YEAR

Cutting back the leader prevents the side branches being outgrown. By the second or third year the main branches should be well spread and developed. Head back to either point, as indicated. This three-year Montmorency also needs some thinning out and heading back to avoid crotches.

How the Fruit Buds Are Borne

A bud is produced with each leaf along the new growth. (Fig. 9.) These buds are of two kinds, "leaf" buds and blossom or "fruit" buds. The leaf buds produce a woody growth the season after they are formed; the blossom buds produce only blossoms. (Fig. 10.) If the growths from the leaf buds are short, from one-half to one inch or less in length, they are called spurs. (Fig. 9.) Longer growths are spoken of in this paper as branches, without regard to whether they are borne laterally or terminally.

The amount of growth which a branch makes largely determines whether it will bear leaf or blossom buds or some buds of both kinds. Growths under six inches long will bear mostly blossom buds and those over 12 to 14 inches long will have mostly leaf buds. It is seen, then, that spurs and short branches will have practically all blossom buds. The terminal bud is a leaf bud. The new terminal growth comes from this bud each season.

The blossom buds of a tree are borne on spurs and as lateral buds on branches. When most of the buds are on the spurs it is said that the tree has a spur fruiting system; when the majority are on the branches, a lateral (bud) fruiting system, although the tree is bearing buds on both spurs and branches in both cases. In general, dense trees have a lateral fruiting system and open trees a spur system.

The ratio of wood growth to blossom bud formation varies somewhat with the season, the variety, the age of tree, the vigor of the tree and the part of the tree. The development of a spur fruiting system depends, however, upon keeping the tree growing vigorously, as leaf buds, from which spurs grow, are present in large numbers only on rather long growths, as shown by Table I.

TABLE I.—PERCENTAGES OF LEAF BUDS ON TERMINAL GROWTHS

Length of terminals in inches	1917	1918	
	Richmond	Richmond	Montmorency
4	0.0	2.3	4.3
6	8.47	4.8	6.3
8	10.59	9.2	22.8
10	20.47	17.1	30.1
12	46.07	24.2	53.9
14	67.95	43.	75.
16	....	65.3	82.4
18	....	75.8	93.7

Besides showing the increase in percentage of leaf buds as the length of the growth increases, Table I shows that Montmorency

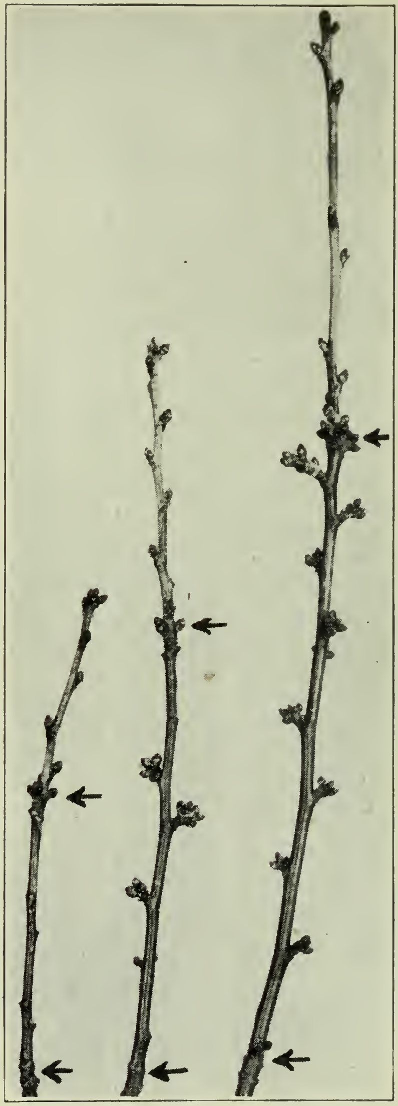

FIG. 9.—KEEP UP THE GROWTH AND DEVELOP A SPUR FRUITING SYSTEM

Buds are formed with the leaves on new growths (above the top arrows) . These are either blossom or "leaf" buds, depending largely upon the length of the growth. Short growths of less than six inches (at left between the arrows) form mostly blossom buds which produce blossoms and fruits and perish; longer growths of six to ten inches (in center) have some leaf buds which develop into spurs or branches the next season; and long growths as 10 to 15 inches (at right) have mostly leaf buds.

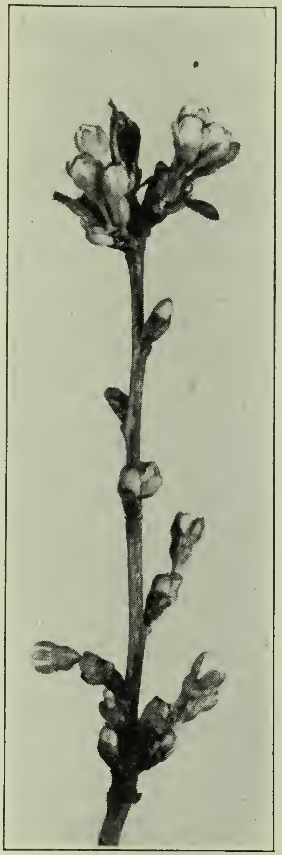

FIG. 10.—THE BLOSSOM BUDS ALONG THE SHORT BRANCHES OFTEN WINTER KILL

The spur buds are much hardier than blossom buds. The blossoms of the undeveloped buds are dead. Each bud should produce three to five blossoms as at the tip. Such growths form no spurs as all the buds are blossom buds.

trees had many more leaf buds on growths of 8 to 10 inches long than Richmond trees. Because of this variety habit, it is easier to develop a spur system with Montmorency than with Richmond.

SPUR BUDS ARE HARDIER

A large spur fruiting system is better than a large lateral fruiting system. Spurs should form new terminal growths and blossom buds and produce fruit for several seasons as compared to the one-year crop on the branches. The greater height of many of the terminals adds to picking troubles. A more important advantage in favor of the spur fruiting system is that the spur buds are hardier than those borne on the branches. This is shown by Table II.

TABLE II.—WINTER KILLING OF BLOSSOM BUDS ON SPURS AND BRANCHES, 1918

Variety	Age	Spurs		Branches	
		Per cent of dead buds	Blossoms per live bud	Per cent of dead buds	Blossoms per live bud
Richmond	16	59.2	2.37	86.1	1.75
Montmorency	16	44.1	1.73	85.4	1.52
Richmond	6	33.4	2.33	90.2	1.74
Montmorency	6	13.4	2.49	73.2	1.81
Average	....	37.5	2.23	83.7	1.71

Table II shows the marked difference in winter injury between the spur blossom buds (Fig. 9) and blossom buds on branches. (Fig. 10.) Only 37.5 per cent of the spur blossom buds were killed while 83.7 per cent of the buds on the branches were dead in the spring. Usually one or more of the four or five blossoms in the "living" buds were killed. The buds on the spurs developed 2.23 blossoms each, and those on the branches had but 1.71 blossoms to each bud. Thus, each 100 spur buds developed 139 blossoms while 100 buds on the branches produced but 28 blossoms.

Less than a half crop of fruit could have been produced on the branches if all the living blossoms developed into cherries. More than enough of the spur-bud blossoms were alive to give above the average yield. Since having spurs in the tree means the difference between a crop and a failure when winter injury is very severe, as in 1917–1918, the value of a large spur fruiting system as a means of avoiding winter injury of the blossom buds is seen.

MONTMORENCY SPUR HABIT GIVES HARDIER BUDS

Table II also shows that Richmond buds are more subject to killing than Montmorency buds. This difference does not appear to be enough to account for the fact that, in general, Montmorency trees had plenty of blossoms in 1918, while Richmond trees had too few for a crop. The difference seems to be due to the greater number of spurs on Montmorency trees.

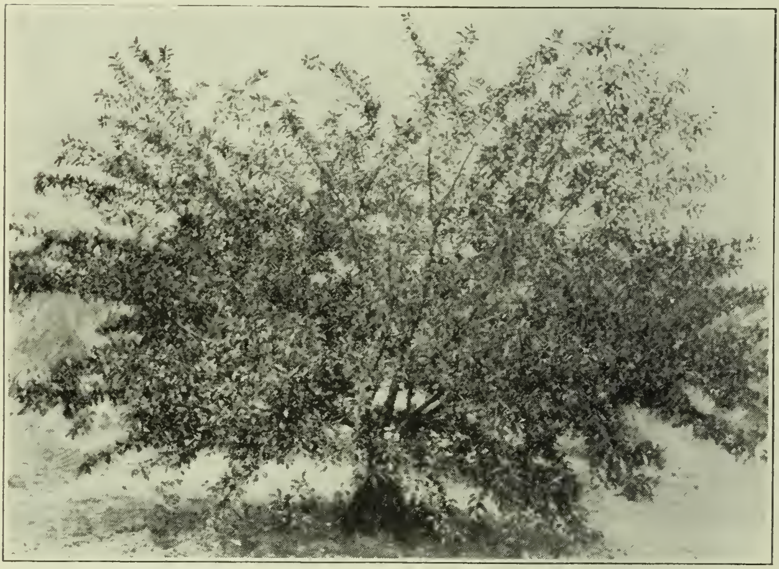

FIG. 11.—THIS TYPE OF OPEN TREE BORE FRUIT IN 1918

This eight-year old open center Richmond tree has many spurs and consequently many "hardy" buds. The top has been kept open by removing of lateral limbs. Heading back the top (Fig. 15) will keep the low wood alive and secure fruit low down. A good tree but less desirable than Fig. 12.

It was found that average Montmorency trees, eight to ten years of age, which had been pruned but little, had nearly twice as many spurs as unpruned Richmond trees of the same ages. They averaged about 3,750 and 2,200 spurs respectively. With most of the buds on the branches dead, 2,000 spurs having 40 per cent of dead buds form too small a fruiting area to produce a crop of fruit on trees of this age, even should all the living blossoms develop into fruits. In seasons when the buds are badly injured, a short crop is borne on trees with rather few spurs.

PROPER CARE GIVES SPURS AND HARDY BUDS

Some Richmond orchards had enough blossoms to produce a crop of fruit in 1918. In all such cases it was found that these fruitful trees had a larger spur fruiting system, as a direct result of the pruning and care given the trees. It was found that open-topped trees of six to seven years or age had as many spurs as eight- or nine-year-. old trees which had been given little or improper pruning and had dense tops. Where the terminal growth was kept long a spur fruiting system was developed and if this had been saved by keeping the tops of the trees open a crop was secured under unfavorable conditions.

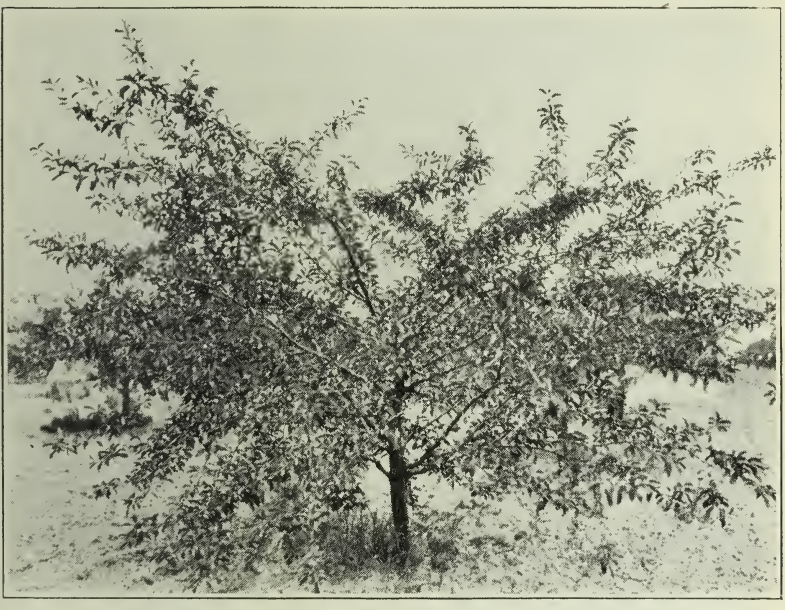

FIG. 12.—THIS TYPE OF TREE ALSO BORE WELL IN 1918

A six-year Richmond. A modified leader tree and more spreading and lower than Fig. 11. Some thinning of crossing limbs is needed. Although this type of tree has apparently little wood it actually has large fruiting surfaces.

AVOID TOO EARLY BEARING

Some growers want their trees to bear a crop when very young. While this practice gives small early returns, it is found to be a bad practice in the end.

Heavy crops of fruit on four-year trees are often mostly from blossom buds along one-year wood. As growths of less than six to eight inches form more blossom buds than do longer growths, early bearing is usually the result of little growth being made and takes place at the expense of fruit spur production. The formation of blossom buds on the branches, which increases early bearing, prevents spurs being formed. While early crops may be secured, the development of a spur fruiting system is hindered. Keeping up the growth of the young trees in the end will mean greater returns.

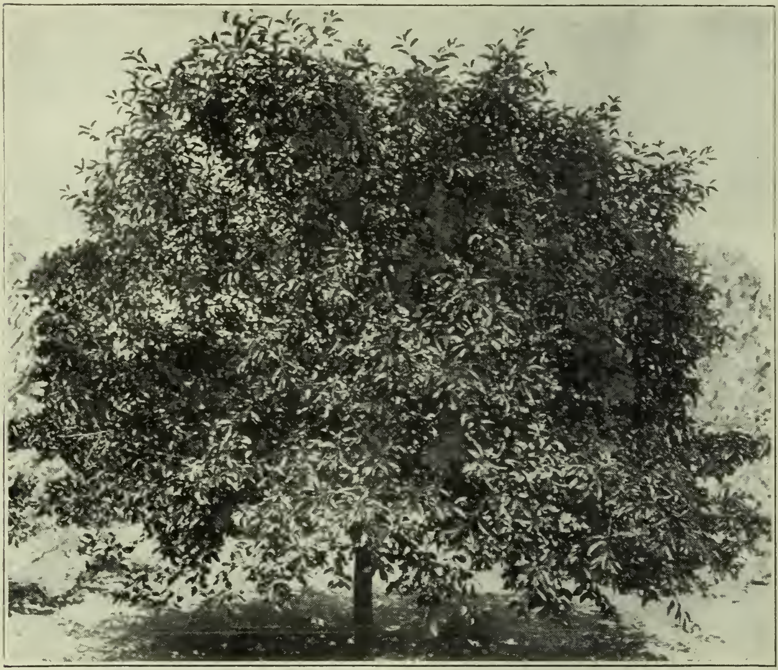

FIG. 13.—DENSE-TOPPED TREES HAVE FEW SPURS

Such trees have many terminals, too much shade, few spurs, tender buds and little fruit. Compare with Fig. 14. See Table III, page 20.

DIFFERENT SYSTEMS OF PRUNING HAVE LITTLE EFFECT UPON THE AMOUNT OF FRUITING AREA

Young unpruned trees are larger and will bear earlier than pruned trees. Pruning reduces the size of the top and checks root growth which, in turn, limits the total top growth the following seasons.

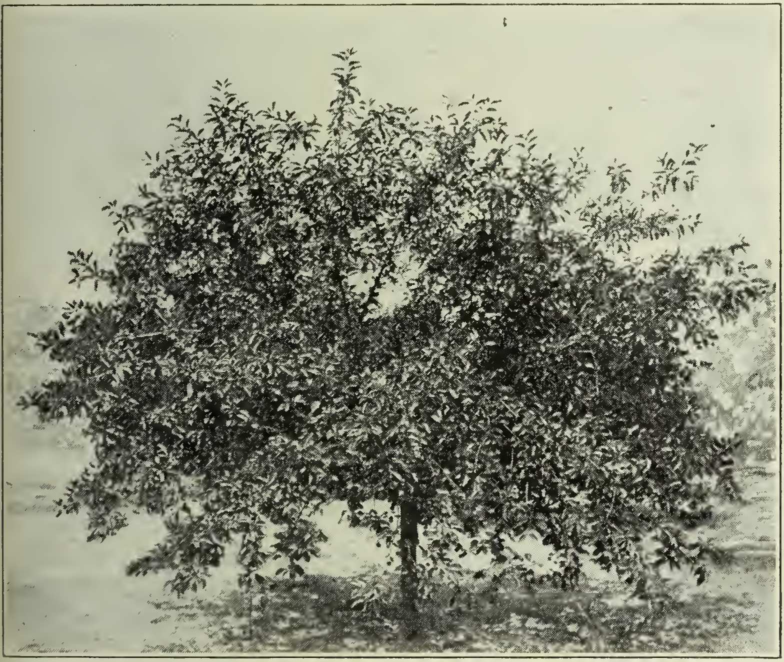

FIG. 14.—OPEN-TOPPED TREES HAVE MANY SPURS

Here are few terminals, plenty of light, many spurs, hardy buds and a crop of fruit. Compare with Fig. 13. See Table III.

Unpruned trees bear earlier than pruned trees because they make shorter annual growths, although more total growth. The difference is apparently due to the number of branches or terminal growths in the two trees. While pruning may reduce the total wood produced it will increase the length of the terminal growth by reducing the number of branches.

Very heavy pruning may greatly affect the amount of fruiting wood in the tree but a study of the pruning systems used in the Sturgeon Bay (Wisconsin) and Grand Traverse (Michigan) districts shows that the style of pruning has little effect upon the amount of fruiting area of trees in the same planting. That is, trees of the same age and under the same orchard treatment will have about equal numbers of blossom buds, even when different systems of pruning have been followed, providing regular pruning of about equal amount is done.

DIFFERENT SYSTEMS OF PRUNING GREATLY AFFECT THE KIND OF FRUITING AREA

The style of pruning, outside of the amount done, has a marked influence upon the number of spur buds as compared with the number of blossom buds on the branches of the tree; that is, upon the kind of fruiting area. Pruning, which reduces the number of terminals, helps to keep up the length of the terminal growth and thus gives a better production of spurs, as a lack of pruning results in short branches, the production of lateral blossom buds and few spurs.

While pruning encourages spur formation, it has an even more direct effect on fruiting in keeping the spurs alive after they are formed. Cherry spurs will not live in heavy shade. Open-topped trees, or at least low-spreading trees, are needed if the low wood and spurs are to be saved. Pruning which keeps the trees low and the tops open can be used to save the spurs after they are formed. Table III shows the average condition found in dense and open-topped trees. The records are of eight-year-old Montmorency trees standing at opposite corners of the same open space. The dense tree (Fig. 13) was larger than the open tree (Fig. 14).

TABLE III.—EFFECT OF OPENNESS OF TOP UPON FRUITING HABIT AND FRUIT PRODUCTION

Dense tree		Open tree
1680.	Number of spurs	2580.
2.3	Blossom buds per spur	3.0
3864	Total buds on spurs	7740.
1610	Number of branches	880.
7.0	Blossom buds per branch	8.8
11270.	Total buds on branches	7744.
15134	Total buds on tree	15484.
24.66	Percentage of live buds on branches	25.33
83.75	Percentage of live buds on spurs	82.4
42.5	Percentage of crop on spurs	72.0
4870	Total fruits per tree	6930.
1.62	Cases per tree (3000 fruits)	2.31

As compared with the large, dense tree the smaller, typical open-topped tree had more spurs, fewer branches (growths of more than ½ inch in length), about equal killing of buds on spurs and branches, and an equal number of buds,—that is, an equal fruiting area. It bore more fruit than the dense tree, because the buds on its greater number of spurs were less injured by cold than the buds along the greater number of branches on the dense tree.

With less severe winter conditions, dense trees would probably have fruited as heavily as trees with more open tops. They could have produced no more fruit, as they have no greater fruiting area. Almost without exception, the only Richmond trees bearing a good crop in the Sturgeon Bay district this year were trees of a very open type. (Figs. 11 and 12.)

The root system of a tree will apparently support about a given number of leaves with their buds. If a tree has a very dense top, the food and moisture supply is so distributed to the excess number of branches that little terminal growth is made and large numbers of blossom buds are formed on the branches. On the other hand, open-topped trees have fewer terminal branches, the growths are greater, leaf buds are formed and the spurs which result produce as many buds as are formed on the dense tree. This is possible because the spurs average about four blossom buds each.

RATHER YOUNG TREES HAVE A MAXIMUM FRUITING AREA

Montmorency and Richmond trees in 20-foot plantings can be expected to reach their greatest fruiting area at 10 to 11 years of age. This stage may be reached at nine years. Heavily fertilized trees which have large percentages of spur buds may continue to add to the total of their fruiting wood until they are 12 to 13 years old. Montmorency trees may be older than Richmond before maximum bearing is reached.

A maximum crop may not be produced by a tree with a maximum fruiting area, as the conditions which give the best setting and development of fruits are known to be different from those causing greatest blossom bud formation.

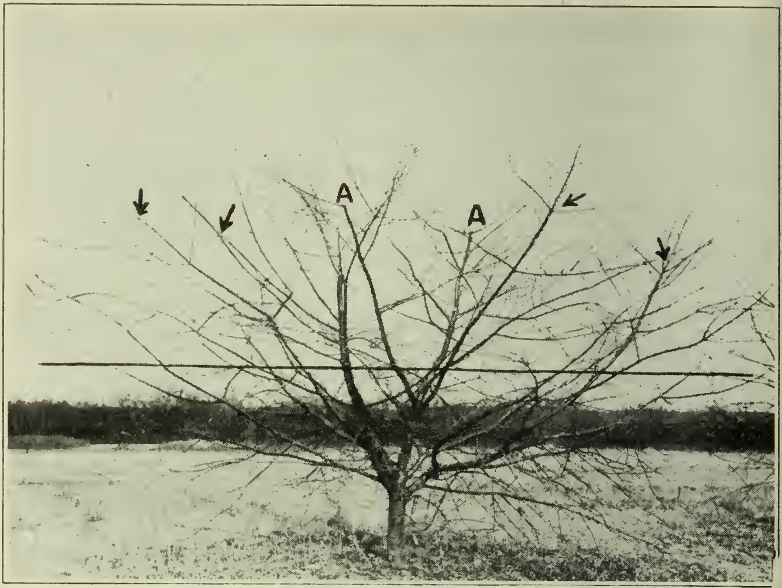

FIG. 15.—HOW TO TREAT MANY OF THE OLDER OPEN CENTER TREES

This tree has been pruned at A. The pruning next year can be at the points shown by the arrows. Note that no tipping is done. This would increase the number of terminals and the amount of shading. The branches are cut back to laterals. Note the large amount of low fruiting wood, under the line, as compared with Fig. 19.

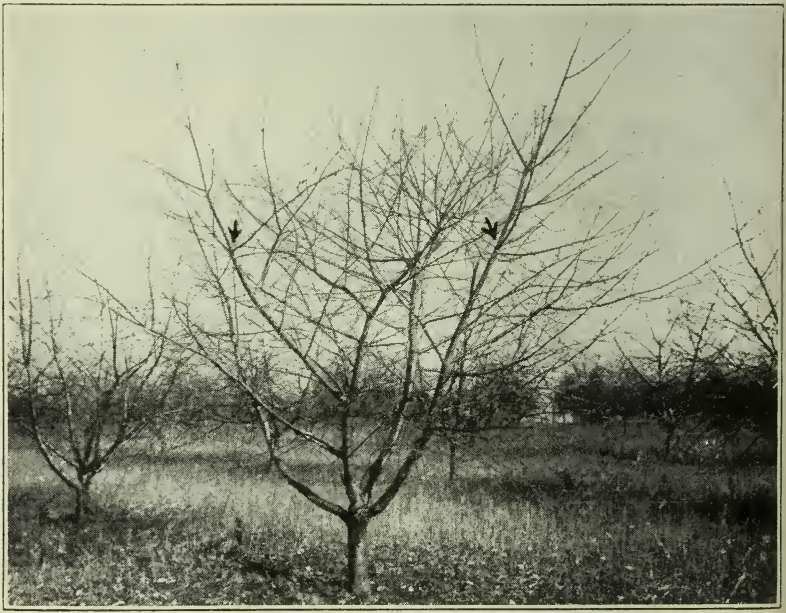

FIG. 16.—THIS "BRUSH HEAP" RESULTS FROM LITTLE PRUNING

No heading back, no removal of crossing or crowding branches but only pruning to remove dead wood has been done. Practically all low wood is dead. Heading back as indicated takes off most of the fruiting wood. Compare with Fig. 15, a tree of the same variety and age.

TREES PRODUCE MANY MORE BLOSSOMS THAN FRUITS

Some trees may have well in excess of 20,000 fruit buds, but 16,000 to 18,000 is an average maximum for Richmond trees. Montmorency trees of equal age usually have an average of a quarter to a third more buds than Richmond trees. If only one blossom out of every four which is formed on a mature tree should develop into a cherry, a large yield of five to six cases of fruit would be produced. Because of this excess of fruiting area, on the average tree, regular pruning can be done without reducing the crop.*

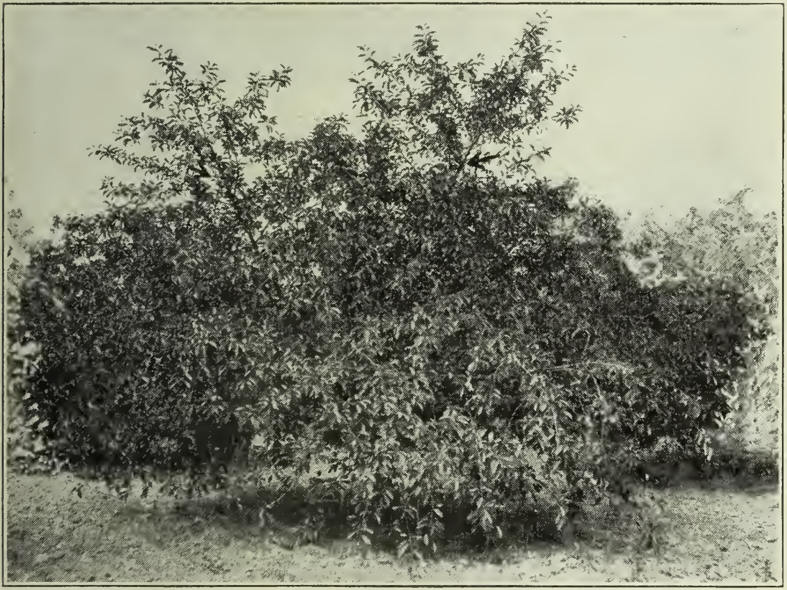

FIG. 17.—ANOTHER ILLUSTRATION OF UNDESIRABLE TOP WOOD

The terminal growth of the few main branches of an open center tree shade and kill off much low wood. Keep the tops low and spreading by cutting back as indicated (also Fig. 15). Determine if the top is too dense while the tree is in leaf and do the dormant pruning accordingly. The lowest wood on this tree has been given very little attention.

OLD AGE DOES NOT INCREASE THE FRUITING AREA

The roots of the trees meet between the rows when the orchard has been set about five years and of an average they extend throughout the surface soil of seven-year-old plantings. The terminal growths become very much shorter about this time. This is, of course, influenced by pruning, cultivation and the amounts and kinds of fertilizers used.

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*The question of the influence of different amounts of pruning upon yield is being investigated at present.

After the trees are about nine to ten years of age, the dying of lower wood, largely because of shading, balances the increase in fruiting wood that might be expected as the trees become older. When the terminal growth averages but four to five inches, as is often the case, almost no new spurs are formed and just about the usual number of blossom buds along the branches are produced. This explains why there is no increase in the amount of fruiting area after much dying of the lower wood begins.

It is often considered that fruit production on the branches means added fruiting area and is thus an advantage. It really happens that the fruiting area of a tree is a rather constant factor and the more blossom buds there are on the branches, the fewer spurs will be produced.

TABLE IV.—RELATION OF AGE AND GROWTH TO KIND AND AMOUNT OF FRUITING AREA ON REPRESENTATIVE RICHMOND TREES, 1918

Age	Branches*			Spurs			Buds total on tree	Per cent spur buds	
	No.	Aver. buds	Total buds	No.	Aver. buds	Total buds			
4	20	4.	80	628	2.75	1,727	1,807	95.5	Large growth.
5	204	8.	1.632	380	3.4	1,292	2,924	44.2	Average tree.
6	390	8.9	3.471	1,768	3.75	6,630	10,101	65.6	Very low open tree.
6	408	9.85	4,019	1,380	3.55	4,899	8,918	54.9	Large, open top.
6	372	9.6	3,571	940	3.9	3,666	7,237	50.7	Medium size, open.
8	650	8.25	5.363	2,780	4.0	11,120	16.483	67.5	Large, very open.
9	554	8.7	4.820	2,325	4.14	9,626	14.446	66.6	Very open tree.
9	930	9 12	8,481	2.300	3.34	7,682	16,163	47.6	Spreading, dense (Fig. 4)
10	1,030	8.4	8.652	1.370	4.1	5,617	14,269	39.4	Large tree, dense (Fig. 3)
10	590	9.25	5,458	2,780	4.	11,120	16,578	67.1	Large tree, open top.
12	800	8.15	6,520	3.035	3.9	11,837	18,357	64.7	Very open top.
12	1,840	8.94	16,450	1,260	5.12	6,451	22,901	28,2	One year after dehorning.‡
14	1.080	9.2	9,936	1,466	4.1	5,811	15,747	36.9	Topped tree, low wood dead.‡
14	1.020	7.8	7,956	2,310	4.	9,240	17,196	53.7	Nitrogen plat, large growth, dense.
14	1,172	8.1	9,493	1,930	3.95	7,229	16,722	43.3	Phosphate plat, little growth, dense.†
16	620	7.85	4,867	2,310	3.4	7,854	12,721	61.9	Low wood dead, little growth.†
18	1,100	8.73	9,603	2,110	3.52	7.427	17,030	43.6	Strong growing old tree.
20	620	7.2	4,464	2,720	3.6	9,792	14,256	68.9	Average tree, low wood dead.†
22	1,205	6.9	8,315	2,195	3.72	8.165	16,480	49.6	Large tree.
22	1.280	8.2	10,496	2,466	4.	9,864	20,360	48.5	Very large tree.
24	444	7.	3,108	1,480	3.95	5,846	8,954	65.1	Med. size. very little growth.†

*Growths over one half inch long. The average number of buds per branch is low owing to a short growth in 1918.

†Many terminal growths are short and class as spurs.

‡Very heavy top pruning forced many spurs into wood growth. Note that the total fruiting area is normal one year after dehorning.

Since large size or old age of trees does not always mean a greater fruiting surface, as shown by Table IV, the more convenient low tree produced by proper heading back would appear to be the type desider.

GROW A LOW SPREADING OPEN-TOPPED TREE

When a cherry tree is being grown, it is preferred almost above all else that it be kept low because of ease of harvesting.

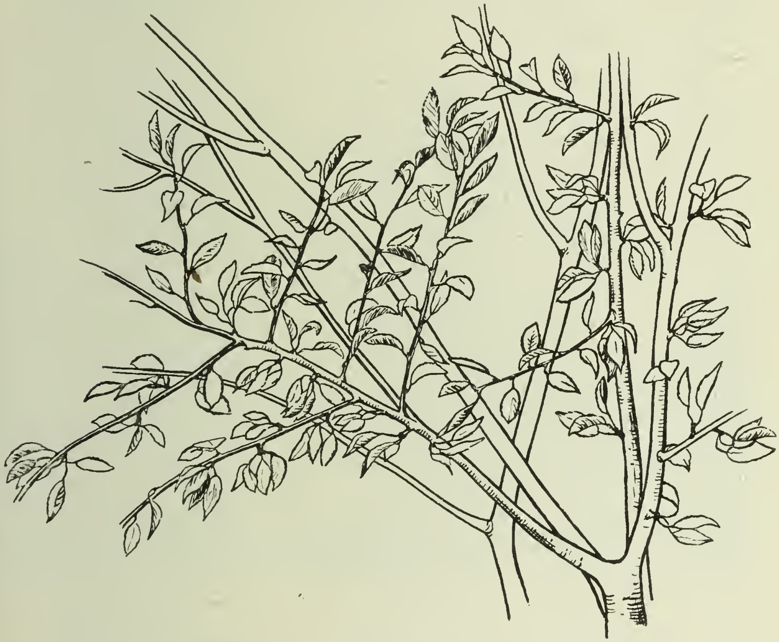

FIG. 18.—OVER-THINNING OF THE TOPS FORCES THE SPURS INTO WOOD GROWTH

One of the benefits of a spur fruiting system—bud hardiness—is lost by over-thinning. Keep the tops properly thinned out as the tree develops and avoid too heavy cutting.

The present studies indicate that by pruning the trees may be kept low without seriously reducing the fruiting area. Pruning also reduces probable winter-killing of the blossom buds. At least, the buds which develop on spurs following heavy growth, such as pruning encourages, are much hardier than the buds along the branches. Openness of the top resulting from pruning is also needed to keep the lower fruiting wood alive. (Fig. 15.)

HOW TO PRUNE THE CHERRY TREE

The following outline is offered as a guide in growing the best cherry trees.

1. Grow a modified-leader tree to give a strong head. Fig. 8.) Trees with many main branches are best. Four or five of the original branches may be left at planting if they are well placed. It is best to develop four or five more from the leader during the next two seasons. Trees of this type are more spreading, are easier to pick from and they have a much better spur fruiting system. (Fig. 3.)

2. Unless the annual growth is over 18 inches long, little tipping is needed. Growths over 20 inches long should be headed back to prevent legginess of the branches. Unequal heading prevents weak crotches. (Fig. 7.)

3. Keep the top free from crossing limbs and excess branches. (Fig. 16.)

4. Supplement pruning with thorough cultivation to help keep up the terminal growths to insure spurs being formed.

5. After five to six years, special care is needed to keep the tops thinned out or "open" to admit sufficient sunlight to keep the inner spurs and lower fruiting wood alive. (Fig. 17.) The main operation is to head back the taller branches and those which grow toward the center of the top. These branches shade and thus kill out much more of the lower, more desirable wood than they produce by growing tall. Cutting back should be done to lateral branches.

   If a rather dense top is too severely thinned out, such spurs as remain often make a shoot growth. (Fig. 18.) This forcing of the spurs into shoot growths is undesirable as one of the principal assets of the spurs—bud hardiness—is lost. The blossom buds on these shoots are as subject to winter killing as the buds on the branches.

6. Annual pruning should be done to avoid heavy cutting at any one time. The amount to prune varies with each individual case. Needed cutting should be done without fear of reducing the yield, as the tree develops blossoms far in excess of its ability to mature fruits.

7. It is a mistake to cut off the low wood. (Fig. 19.) With trees six to seven years old, 20 per cent of the crop is often produced on wood within less than three feet from the ground. This low wood can be thinned out as needed and thus kept in profitable bearing condition. (Fig. 15.)

VARIETY HABITS AFFECT THE PRUNING

The pruning practices will be affected by differences in the habits of growth of different varieties. It is more difficult to grow a spreading Montmorency than a Richmond tree owing to its more upright habit. It will require heavier pruning to get a large spur-fruiting system on Richmond trees because of their tendency to form blossom buds on the branches. Montmorency spurs are longer-lived than those of Richmond. It is possible this may be due to a difference in ability to stand shading. Although Montmorency trees can be left more dense without apparent harm to the spurs, it is desired that the trees of both varieties be low and open-topped.

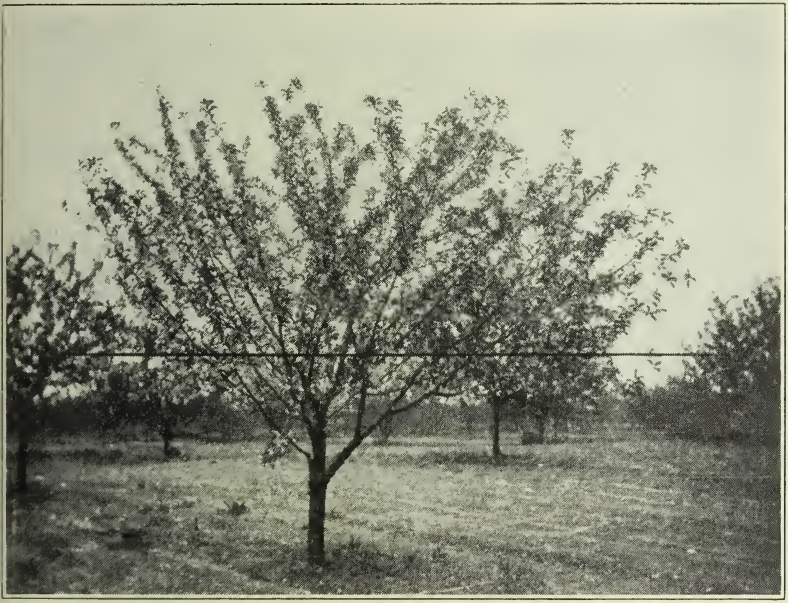

FIG. 19.—KEEP THE LOW FRUITING WOOD ON THE TREES

High heads and removal of the low wood increase the harvesting troubles. Compare with the better types, Figs. 11, 12, 15 and 17.

The Morello has been little observed. From its semi-dwarf habit and extreme tendency to form blossom buds on the branches, it would seem best to prune it more after the style of the peach, though less severely.

SHOTHOLE FUNGUS KILLS THE SPURS

All the gains in developing spurs by pruning may be lost if the trees are allowed to become affected with shothole fungus. The early falling of the leaves starves the spurs to death.

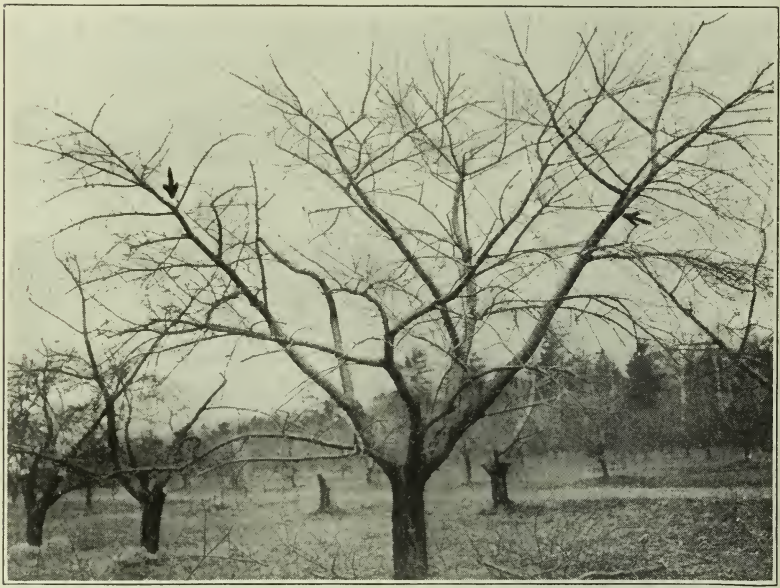

FIG. 20.—REJUVENATION PRUNING IS TO BE AVOIDED

Keep the trees within bounds as they develop. Thinning out as done here is not severe enough to force new spur-bearing wood on average old cherry trees. Apple trees which have more permanent fruiting spurs may be treated in this way. Cutting back at such points as indicated forces a strong new growth as well as lowers the top.

RENEWAL PRUNING IS BETTER THAN REJUVENATION PRUNING

The old cherry tree seems to offer little chance for rejuvenation pruning or dehorning. It should be kept growing strongly by regular renewal pruning, as has been outlined. There are, however, older trees which have already been allowed to grow too tall for profitable harvesting. The possible treatment for these depends largely upon two questions.

How much growing wood remains in the lower part of the tree?

What is the condition of the trunk?

Severe heading back is sometimes practiced upon overgrown trees. (Fig. 20.) While this severe cutting back is undesirable and should be avoided by doing earlier pruning, it is, however, entirely practical under the circumstances, especially if there is still a large amount of low fruiting wood.

Very few "suckers" will grow from near the cuts if the branches are cut back to near large laterals. The main objection to such cutting seems to be that large numbers of the fruit spurs are forced into wood growth as previously mentioned. (Fig. 18.) There is also a temporary loss of fruiting area. This, however, soon returns to normal and the tree is free from its former unprofitable high wood.

True rejuvenation of weak, sickly trees will usually not pay, as the trunks of such trees are generally so badly decayed that there is no foundation upon which to build. With sound trunks, new tops can be produced wherever it is possible to cut back to growing shoots or small branches. (Fig. 20.) The cherry does not readily make sucker growths, so success in heading back depends largely upon having growing points near where it is desired to do the cutting back.

PRUNING CANNOT TAKE THE PLACE OF SOIL FERTILITY AND CULTIVATION

Pruning alone should not be depended upon to give the best crops of fruit. To regulate the amount of growth by pruning alone is too expensive. It would also mean a probable serious reduction in the amount of fruiting area because of too heavy pruning. Proper cultural methods are a better means of keeping up a strong growth of the trees. As previously mentioned, in 20-foot plantings the tree roots come together between the rows when the orchard has been set about five years. At seven to eight years the roots have grown throughout the surface soil. While plenty of soil fertility has been needed before this time, it is of more value as a means of keeping up the wood growth of the trees from this time on. It should be kept in mind that the amount of growth produced is principally the result of cultural conditions. While pruning helps to keep up the growth of the tree, its chief role is to maintain the spur system of the tree after it is formed, and to keep the tree "within reach of the ground" so that spraying and picking can be done cheaply.

DON'T SOW THE COVER CROP TOO EARLY

The use of a cover crop to check the growth of the trees to prevent winter-killing of the new wood is largely unnecessary in the case of bearing trees. In most cases the terminal buds have formed before cherry harvest and long before danger of too late growing is possible.

The fault of bearing trees in Wisconsin is that they fail to make as much growth as is desired and not that they grow too late in the summer. More growth is desired than is usually made. Even in cases where a strong growth is being made, sowing a cover crop too early or letting the early weeds grow as a cover to hold the snow, may ruin the effects of fertilizing or pruning in keeping up the growth of the tree.

This opportunity is taken to express a grateful appreciation of the assistance given by M. B. Goff, County Agricultural Representative in Door County, for aid in collecting the data upon which the recommendations in this paper are based.

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Bulletin 299 March, 1919

Sandy Soils and How to Farm Them

A. R. WHITSON and H. W. ULLSPERGER

PROPER CULTIVATION BRINGS RESULTS

A dust mulch keeps the moisture in the loose sandy soil. Cultivation also kills the weeds. Frequent shallow cultivation pays.

AGRICULTURAL EXPERIMENT STATION
OF THE UNIVERSITY OF WISCONSIN

MADISON

DIGEST

Proper methods of cultivations will make it profitable to farm all but the poorest of the sandy soils of Wisconsin. The right crops, proper fertilization and management are essential. One-fifth of Wisconsin's area (6,000,000 acres) is classed as sandy loam, fine sand and sand. Pages 3 to 4

To improve sandy soils, acidity must be corrected, humus added to hold the soil together and help hold the moisture, blowing stopped, and the right fertilizers added. Liming is often the first step, since it makes it possible to grow crops of legumes which fail where the soil is acid. Legumes and manure make sandy soils capable of producing more. Pages 4 to 8

By plowing in the spring, by planting windbreaks, by growing cover crops, by using a corrugated roller, sandy soils may be protected and improved. A firm seed bed together with thorough cultivation to conserve moisture and kill the weeds makes profitable crops possible. Pages 8 to 11

Rotations for sandy soils should provide crops which build up the fertility of the soil. Among the best cash crops are soybean and clover seed. Potatoes can be grown when a good degree of fertility has been attained. Hay, legumes and corn support livestock. The nurse crop is needed to protect the sandy soil in the winter and spring. Rye makes a splendid nurse crop on sand. Pages 11 to 15

Inoculation plays an important part in making the crops of legumes thrive. The soil must be sown with tiny bacteria as well as with the best seed. Pages 16 to 17

Soybeans should be grown on at least a fourth of the sandy soil farm each year. There is a future in soybeans for Wisconsin. Pages 19 to 20

Alfalfa, vetch, buckwheat, sweet clover, serradella, wheat, barley, oats, cowpeas, potatoes, and corn are other crops which require a careful understanding when grown on sand. Garden crops do well. Pages 20 to 26

Sandy Soils and How to Farm Them

When the right crops are grown and proper methods of cultivation are followed, all but the poorest sandy soil can be farmed profitably. Perhaps the crop yields on sands will not be so high as on heavier soils, but the expense of tillage is less and there is less loss of time in doing the work on a sandy farm.

One of the greatest opportunities to increase the agricultural production of Wisconsin lies in better management of sandy soils,—sowing the right crops, following the proper methods of tillage, and properly fertilizing the fields.

KINDS OF SANDY SOILS

Sandy soils are grouped into three classes: those simply called sand, those classified as fine sand, and those known as sandy loams. The first class includes the coarsest sandy soils which it it possible to farm successfully; the soils of the second group are better because they are finer; those of the third are better still, for they contain more silt and clay.[1] Wisconsin has more than 6,000,000 acres of soils of these three classes, or about one-fifth of her entire area.

The farmer on a sandy farm should know what crops to grow to provide a living and at the same time build up the soil to the desired fertility.

CASH CROPS NECESSARY

Two principles are necessary to success in farming on sandy lands: First, to maintain himself on his land the farmer will need to grow certain cash crops which do not require much fertilizer nor make too heavy demands on the soil; second, he must grow legumes to build up his soil, feed them to livestock and return the manure.

Soybeans, clover seed, rye, potatoes, and garden truck are among the cash crops which can be grown. Buckwheat and oats are often grown, but they do not pay as great a profit. Wheat and barley do not grow well on sandy soil. Where market conditions are favorable, garden truck and small fruit are satisfactory as cash crops in combination with dairy farming.

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[1] All soils contain sand, silt and clay. The coarser particles are sand, the finest, clay, and the intermediate, silt.

WAYS TO IMPROVE SANDY SOILS

To increase the crop producing ability of sandy soils requires, first, that blowing of sand be stopped; second, that possible acidity be corrected; third, that humus be added to bind the soil particles together and increase its moisture-holding capacity, and fourth, that elements lacking in the soil be supplied through application of proper fertilizers. Clover, alfalfa and other legumes, either plowed under for green manure or fed to dairy cattle and the manure returned to the soil, will add nitrogen and humus. The addition of nitrogen phosphate and potash in some of their more available forms as fertilizers is frequently necessary.

LIMING IS FIRST STEP

Liming is the first step in building up both the chemical and physical condition of a light, acid soil, because clover, alfalfa, vetch and soybeans, all good crops for sandy soils, cannot be profitably grown on sour land. Liming of the soil and inoculating with the proper bacteria are both necessary to the successful growing of legume crops, but liming comes first.

The practice of liming is often condemned for not producing results when the cause of the trouble is that the lime has not been used correctly. Because the degree of acidity or sourness in soils varies, different amounts of lime may be needed for different filds. Virgin or newly cleared lands are usually only slightly acid. Black sand and sandy soils that have been cropped for a long time are often very sour. Good results cannot be expected if only light applications of lime are made on land that needs a heavy application.

Acidity tests will determine how sour the land is. These tests are made free of charge by the Soils Department, College of Agriculture, Madison, and recommendations are given as to the amount of lime to apply. To secure the best results and to save money it is always advisable to have the tests made.

That lime is a great benefit to legume crops on sandy soil has been proved at the Sparta station, where a field of clover hay on which two tons of lime were applied with manure yielded 1,110 pounds more than a field where manure only was used. At the Marinette county demonstration farm the yield of alfalfa hay was increased from 1,820 to 4,160 pounds by the use of one ton of lime. Two tons of lime applied yearly to a field of soybeans at the Sparta station increased the yield of soybean hay an average of 1,164 pounds a year.

METHODS OF DISTRIBUTING LIME

Lime may be applied as ground limestone, ground marl, ground shells, quick lime, air-slacked lime, or refuse lime (lime carbonate) from glue factories, tanneries, and beet sugar factories. Names of dealers who supply lime carbonate may be obtained from the College of Agriculture, Madison.

Lime in any pulverized form may be distributed by putting a thin layer over the manure in the manure spreader and setting the spreader at the lowest gear; by using some form of distributer especially adapted for spreading limestone; or by shoveling carefully from a wagon box. Only when the lime is damp should the last method be used.

Where only quick lime is available, it may be dumped into piles of about one-half peck each, using about 1,300 pounds to the acre. A little water should be thrown on the lime and the piles then covered with earth. After the lime slacks, more earth is added, and the material is spread with a shovel. Another method is to slack the lime in a box on a wagon, and after it is broken into fine particles to spread it broadcast with a shovel.

Ordinarily, lime should be applied in the fall, preceding the spring seeding to clover. Considerable time is necessary for the lime to act on the acid condition of the soil. Ground limestone may be applied to growing crops but lump lime cannot be applied safely in late spring because its caustic action may kill the young growth. No matter in what form lime is used it should always be applied as a top-dressing and disked in. If plowed under it is carried downward in the soil very rapidly and is less effective in neutralizing the acidity of the soil.

Unleached wood ashes are another source of carbonates that neutralize soil acidity. They also add potash in a very available form. One thousand to 2,000 pounds an acre may be applied to light, sandy soils.

ADD ORGANIC MATTER (HUMUS)

Humus is added to the soil to aid plant growth. It lightens the soil, makes it hold more moisture, keeps it in a workable condition, tends to hold its particles together, and helps in the chemical processes which make the elements in the soil available to the plant for food. Humus is organic matter, or matter which was once alive and growing, in contrast to mineral matter, such as phosphate rock. Manure and the straw or stalks, when plowed under, add humus to the soil.

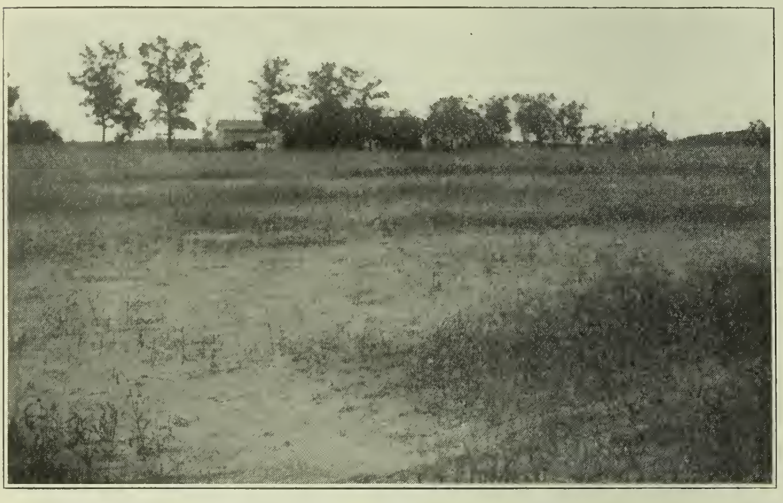


FIG. 1.—THE RESULT OF SEEDING RYE LATE

Late seeded rye makes a poor cover crop. Compare this field of rye with Figure 6 where the rye in both fields was seeded early.

It has been mentioned that the raising of legumes benefits the soil by increasing the humus and by supplying the soil with nitrogen. Other crops such as rye, buckwheat, and millet will also increase the humus if plowed under as green manure, but to a much less degree because of their smaller root systems. Neither do they benefit the soil by adding nitrogen.

The nitrogen and humus necessary to soil fertility are maintained only where the crops are plowed under frequently, or where they are fed and the manure returned to the soil. Furthermore, legume crops alone do not add phosphorus, potash or lime to the soil. Manure or commercial fertilizers are, therefore, necessary to supply these plant food elements.

LEGUMES AS GREEN MANURE

The value of a crop as green manure is closely related to the fineness of the stalk and root system, the place of the root system in the soil, and its relation to lime. A shallow, much-branched root system supplies a great deal of humus near the surface of the soil. Plants that are heavy feeders on lime are best suited to precede a planting of corn.

To determine the value of different legume crops in supplying humus and nitrogen to the soil, a test was carried on at both the Sparta and Ellis Junction farms. The experiments emphasized the need for growing considerable clover on sandy land.

TABLE I.—THE VALUE OF LEGUME CROPS FOR GREEN MANURE

Preceding legume crop	Yield of corn following legume	
	At Ellis Junction	At Sparta
	Bu. an acre	Bu. an acre
Clover	62	42
Alfalfa	53	....
Serradella	44	45
Soybeans	40	26
Vetch	38	21
Cowpeas	32	24
Lupine	33	20
No legume	30	6

The amount of green material turned under varied slightly. The table shows that clover is the best cropt for building up the soil, with serradella a close second. Alfalfa ranks high, but it is a difficult crop to grow on the poorer sandy soils. Soybeans do not give as good results for a green manuring crop as clover or serradella. Cowpeas, lupines, and vetch cannot be strongly recommended.

USE OF MANURE ON SANDY SOILS

Stable manure will always be the chief fertilizer used on farms on which much stock is kept, even though it is necessary to supplement it with phosphates and other fertilizers in order to get the best results. All manure produced should be very carefully preserved and its use studied in order to get the best results. One of the best places to use manure on sandy soils is on the legume crop, especially clover. When applied on corn or potatoes and plowed under early, there is often some loss by leaching before these crops are far enough advanced to absorb the fertility from the manure, but when applied as a top-dressing on clover, the quick growth of the clover absorbs the fertility. However, it is only moderate applications of manure which should be used in this way. If there is more than necessary to give a light dressing to the clover, it should be used on corn or other crops.

Light and frequent applications of manure give better results on sandy soils than heavy application, as there is danger of loss by leaching when heavy applications are made at widely separated intervals.

THE TILLAGE AND PHYSICAL MANAGEMENT OF SANDY SOILS

SPRING PLOWING BEST

On sandy soils underlain by sand, spring plowing is preferred to fall plowing. Covering such soils during the fall and early spring with a good growth prevents loss of plant food by leaching and the loss of the finer sand particles by severe winds. Seeding rye in the corn rows at the time of the last cultivation, or in potato fields at digging time will prevent much loss of fertility.

CLOVER BEST COVER CROP

Rye, seeded early in the fall, will serve as better protection for the soil than if seeded later. Rye, however, has limitations as a cover crop. Severe windstorms will tear it up and carry away the sand, leaving large bare spots in the field.

Packing the soil with a corrugated roller and listing corn are effective in helping to stop blowing. The cheapest and most profitable way of handling the blowing problem on sandy soil is to grow clover. It acts as a cover crop; it increases the fertility; it supplies humus which binds the soil particles together and increases the water-holding capacity of the soil. With clover to hold the soil in place and a windbreak of jack pine and scrub oak to stop the wind, the blowing problem can be overcome.

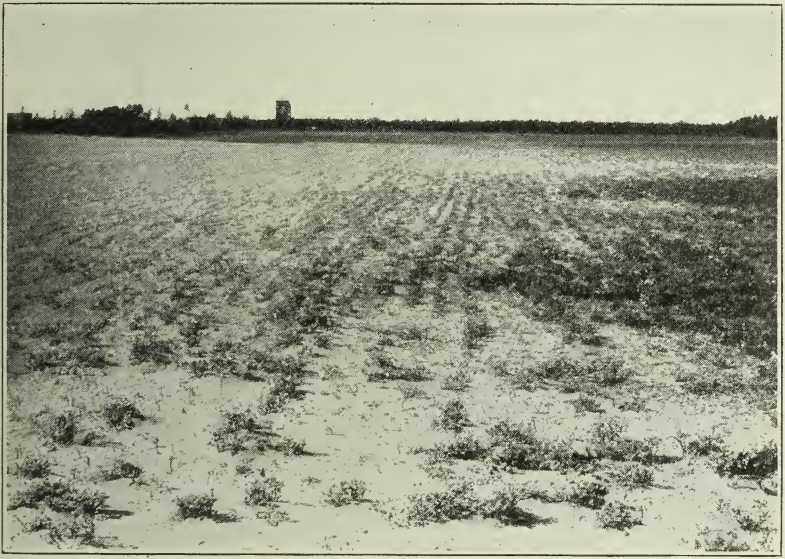


FIG. 2.—CLOVER HOLDS THE SOIL.

Cover crops prove their value on soils having a tendency to blow. Clover will prevent blowing, improve the soil and produce a hay crop.

Protect Fields by Planting Windbreaks

Originally nature, through a forest and vegetative covering, protected these loose sands against severe winds. Man removed the forest covering to secure the land, and later, by constant cropping and removal of crops, removed the organic matter which bound these soils together. This process has continued until many acres are left to the mercy of the winds. This trouble is increasing, for with the removal of the forests, winds are being obstructed less and less, and sandstorms are more severe and of more frequent occurrence each year. Farmers who live in the sandy soil regions agree that each spring's sandstorm is worse than preceding ones.

The remedy is to study and follow nature. On lands which are very low in fertility and which cannot be brought back under cultivation new forests should be started, the usual practice in European countries. Even on farms which are cultivated it is advisable to plant a windbreak around all fields. When new land is cleared it is well to leave a windbreak a rod or two wide. However, windbreaks alone will not prove effective but should be used in connection with a system of cover crops which actually hold and bind the sand particles together.

Firm Seed Bed Desirable

A roller which leaves the surface of the ground smooth is used in many localities to make firm the seed bed. This tool is objectionable because it leaves the ground in a condition that offers less resistance to the wind, and evaporation of moisture will take place more rapidly than where a mulch covers the soil. These objections, however, may be overcome if a light harrow is used after the roller to roughen the surface.

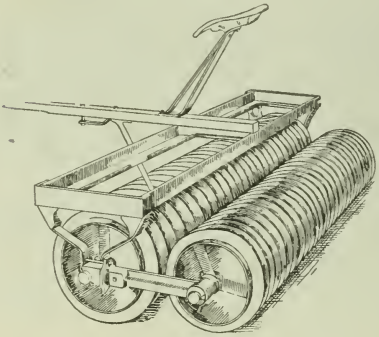


FIG. 3.—A CORRUGATED ROLLER

Properly used, this implement helps in raising profitable crops on sandy soils.

A combination corrugated roller and pulverizer now on the market packs the surface and at the same time leaves it very rough, thus stopping the blowing. This type of roller has been used successfully on sandy soils in producing better stands and larger yields. At the Sparta station, the yield of clover hay was increased 610 pounds to the acre by its use.

Cultivate to Save Moisture and Kill Weeds

All of the soil water comes through rain or snow fall. Of course, more rain falls during a season than is needed by crops, but it is not evenly distributed and often does not come when most needed. Sandy soils are naturally quite loose and open, thus permitting the rapid circulation of air, which causes considerable loss of moisture through evaporation. The size of the crop is often limited by the lack of moisture, particularly at the time when the seeds germinate.

To conserve and hold for later use the moisture gained by the heavy spring rains, it is necessary to make a dirt mulch on the surface of the soil. This is done by cultivating.

Harrowing every ten days, or after every rain in the growing season, will keep such a mulch and conserve much of the moisture. A light drag or weeder may be used for this purpose. The same tools may also be used with good results on such crops as oats, corn, rye, and potatoes, after they are four or five inches above the ground.

Another purpose in cultivating is to kill weeds. Timely cultivation also hastens the warming of the soil, especially after heavy, cold rains.

CROPS AND ROTATIONS FOR SANDY SOILS

Grow Legume ~~Potato~~ Crops to Increase Humus

Rotations for sandy soils should be so chosen as to increase the amount of vegetable matter and provide a legume crop to cover the soil at least once every three years.

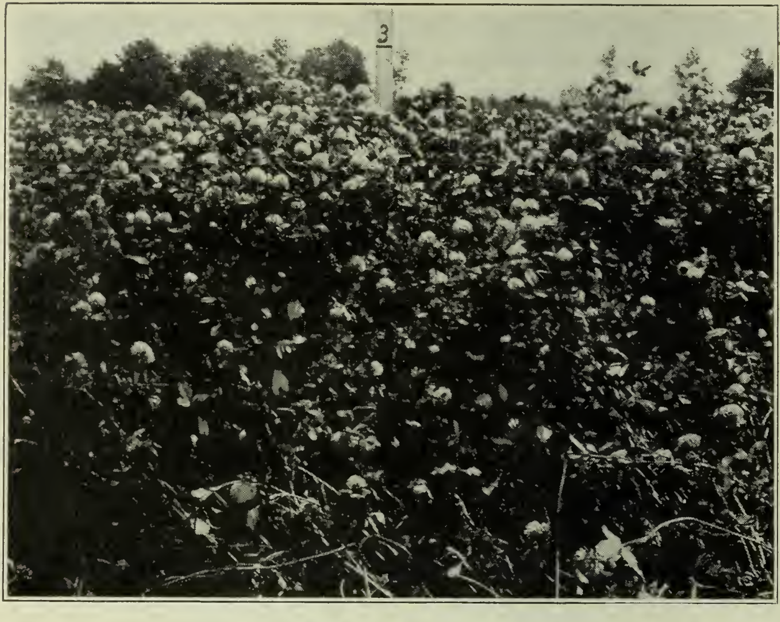
The adoption of a system of rotation ordinarily depends upon the following factors: (a) the type of soil; (b) the location regarding the temperature and rainfall; (c) the market facilities; (d) the farmer's preference as to kind of crop and acreage of cereal, grass and cultivated crops to be grown; and (e) the fertility of the soil.

Due to the wide distribution of sandy soils in this state, and the different conditions and prejudices in each locality, it is impossible to recommend a form of rotation for universal adoption. The one important fact, however, that all sandy soils are low in fertility and especially in nitrogen, generally holds. The acreage of grasses, cereals, and cultivated crops should be chosen with this fact in mind, understanding thoroughly that the nitrogen supply will depend on the growing and handling of legumes.

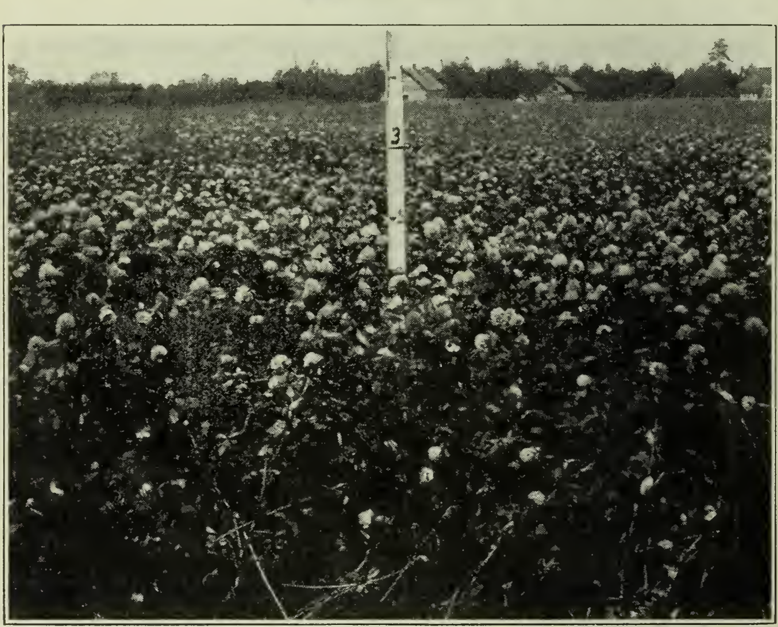
Suggested Rotation for Sandy Land

The following rotation is probably the best for most forms of sandy soil:

First year—clover with perhaps a light seeding of rye.



Mammoth Clover



Medium Red Clover

FIG. 4.—CLOVER IS THE BEST SANDY SOIL CROP

Mammoth red clover yields better than medium red clover on these light soils. Clover must be the main crop on sandy soils.

Second year—clover for hay, leaving the second crop to be turned under either in the fall or spring.

Third year—corn or potatoes.

Fourth year—soybeans, which may be used for seed, for hay, and for green manuring.

If any other crops are to be grown, they may be planted following clover, thus limiting the quantity of the other crops named.

Once in effect, this rotation will permit the purchase and feeding of more livestock, which is the next step in making farming more profitable on light soils. If more livestock is purchased and the feed grown is fed on the farm instead of being sold, the returns will be more certain and there will be fewer crop failures. By returning in the form of manure all crops grown, the fertility of the soil is maintained and sometimes increased, especially if additional feeds are purchased, as on dairy farms. Thus, larger crops, a more regular income, a growing bank account, a better and more equitable distribution of labor, and a more permanent agriculture are assured.

MAMMOTH CLOVER BEST ON LIGHT SANDY SOILS

Mammoth clover does better on light soils than medium red clover, for it is more hardy and a more vigorous grower, being able to secure its plant food more readily. It grows to about the same size on sandy soils as medium red clover does on heavy soils.

It is better to seed from six to eight quarts of seed to the acre on the poorer soils; a large portion of the seed may fail to grow because of lack of moisture and available plant food. The better the soil the less seed needed. A drill is better than a broadcast seeder because the seed can be planted from an inch to an inch and a half deep to secure more moisture. On clay soils or where clay and silt are mixed with sand, more shallow planting is advisable.

Seeding of clover the last week in April or first week in May is preferable to seeding in June or July, because there is at this time more moisture in the soil to start the young plant. When the dry weather comes, the root system of the plant is developed so that it is better able to secure water. Furthermore, clover grows very slowly in these soils and when seeded late does not grow fast enough to protect itself over winter. When it is planted late in the season or when for some reason it does not make a good growth, a top dressing of straw should be applied in the fall to prevent winterkilling.

SOMETIMES ADVISABLE TO USE A NURSE CROP

Sandy soils should always be protected by a cover crop over winter, and, where possible, in the spring.

On fields unprotected by windbreaks and subject to severe winds a nurse crop for clover may be necessary. This nurse crop should be seeded as lightly as possible, not planted with the idea of securing a large crop. Many failures of clover can be attributed to seeding a heavy nurse crop which takes too much moisture and plant food away from the young clover plant. Another objection to the heavy nurse crop is that it shades the clover too much. When the grain is cut in July or August, the hot sun may kill the clover in one or two days because it cannot stand the sudden change to intense heat and sunlight. It is much better to plant oats or rye in small quantities, cut it with a mower when hot, dry weather comes, and let it lie on the field as a protecting covering to the tender clover plant.

Even where no nurse crop is planted weeds will serve as shelter and, when cut, act as mulch and as shade to the young clover plants. Later in the season all weeds should remain on the field to help hold the snow and protect the plants from the cold during the winter.

Many farmers prefer to seed clover in fall-sown rye. There is no objection to this method providing the field is inoculated, limed, manured as directed, and the rye disked in early in the spring so as to reduce the stand or amount of the nurse crop. The disk, when set in one or two notches, will not injure the rye seriously. It will come up again very readily. Clover may be seeded in the rye field before or after it is disked.

PLOW UNDER OR CUT CLOVER FOR HAY?

Ordinarily the roots of clover or alfalfa contain only about one-quarter or one-third as much vegetable matter and nitrogen as is contained in the plant above ground. When, therefore, it is desired that a considerable increase in humus and in the fertility of the soil be made, it is necessary to turn under the whole crop. In improving extremely sandy soils that have been exhausted by a considerable period of cropping, it should be recognized that if any rapid improvement is to be made it will be necessary to turn under practically the entire crop of legumes even if by so doing the use of the land seems to be lost for one or two years.

As about two-thirds of the organic matter in feed is decomposed in the animal, nearly three times as much humus will be added by turning under a crop of clover as from using the manure which would result from feeding it.

After such lands have been brought to a fairly good condition of fertility, it will be practicable to maintain their nitrogen and humus supply by the growth of legumes in short rotation. This is the case even when the clover or other legume is cut for feed, provided the manure coming from such feeding is returned without loss to the soil. It may be necessary to add the other elements, phosphorus and potash, in reasonable amounts from time to time, since there is a gradual and unavoidable loss of these elements through leaching in the soil and in the management of the manure.

TO GROW CLOVER SUCCESSFULLY ON LIGHT SANDY SOILS

It Is Necessary

- To plow and disk thoroughly.
- To compact the soil with a corrugated roller.
- To have the proper bacteria present.
- To use lime on acid soils.
- To apply a light top-dressing of manure.
- To seed rather deeply (about 1½ inches).
- To seed, preferably, early in spring.
- To use either no nurse crop or a light nurse crop.
- To cut and leave weeds or nurse crop on field to protect clover from sun.
- To apply a light dressing of straw in fall to prevent freezing.

ALSIKE CLOVER ON SAND

Alsike clover is longer-lived than either the medium red or mammoth varieties and is frequently left from three to five years on quite fertile soil. Its root-system forms very close to the surface, and the plant is thus well adapted to damp soils. Sand and light sandy loam which dry out severely at the surface have no great supply of fertility in the surface layer, and are not at all suitable for this plant. Although it has the advantage of being less sensitive to acid conditions, it cannot be recommended as a suitable crop for sandy soils.

INOCULATE FOR CLOVER AND OTHER LEGUMES

On poor sandy soils, where it has been impossible to grow clover for several years, it is necessary to inoculate the soil; that is, to add the bacteria which live on the roots of the clover plant and take nitrogen from the air. This must also be done when alfalfa, soybeans, or other legume crops are grown for the first time. The bacteria which live on the roots of clover may have been present in these soils but because clover has not been grown for some time they have disappeared. Under these conditions inoculation is very important, often marking the line between success and failure.

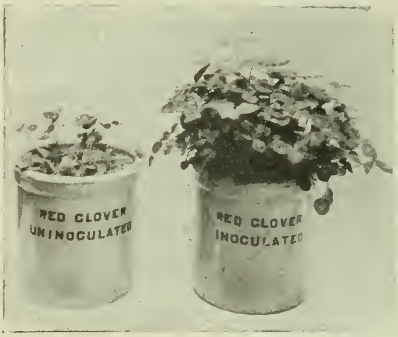


FIG. 5.—WHAT INOCULATION DOES

Bacteria make the difference in these two crops of clover

The soil method of inoculation is old and reliable. Ordinarily it is done by scattering over the field soil on which red clover has been previously grown, and the roots of which show a good development of nodules. The value of the inoculation will depend on the amount of inoculating soil and the thoroughness of its mixture with the ground.

Where such soil is readily accessible, with only the cost of a short haul, it is best to use 1,000 to 2,000 pounds to the acre. About half as much will produce good results if the soil is kept in moist condition. In securing the soil, reject one or two inches of surface soil as the sun may have killed the germs present. It is also advisable to cover the soil with moist burlap sacks to prevent its drying out and to protect it from the sun. It is better to apply this soil on the field to be inoculated just before seeding, and then disk or drag it in immediately. An old-fashioned broadcast seeder or a lime spreader or manure spreader may be used to apply the soil, or a drag may be hitched to the rear end of a wagon and the soil spread by hand just in front of the drag. It is very essential to cover the soil applied to protect the bacteria from the sun.

Commercial cultures are sometimes used for inoculating purposes, but with small seeds like clover and alfalfa, they have not always proved successful. In order to insure thorough inoculation it may sometimes be advisable to use both soil and culture, for upon inoculation largely depends the success or failure of all legume crops.

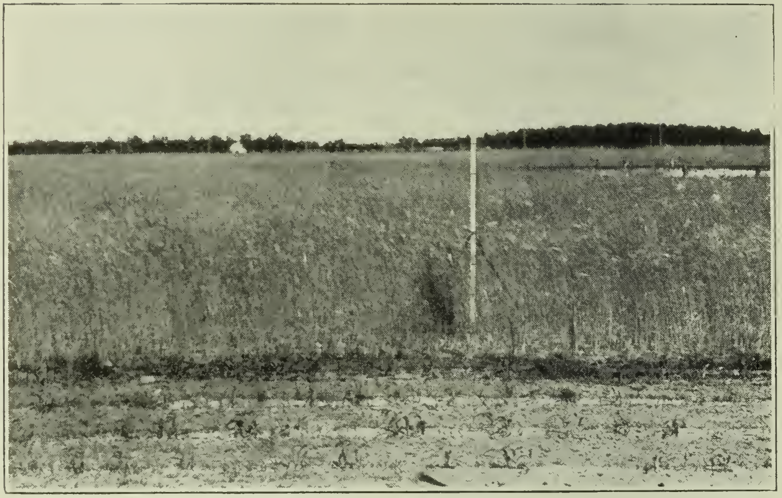
RYE ON SANDY SOILS

Of non-legume crops for sandy soils, rye is probably the best. It grows as well on acid as on non-acid soil and is much better adapted to sand than are wheat, oats, and barley. It withstands dry weather well. Spring rye cannot be recommended as it does not make a very good growth.

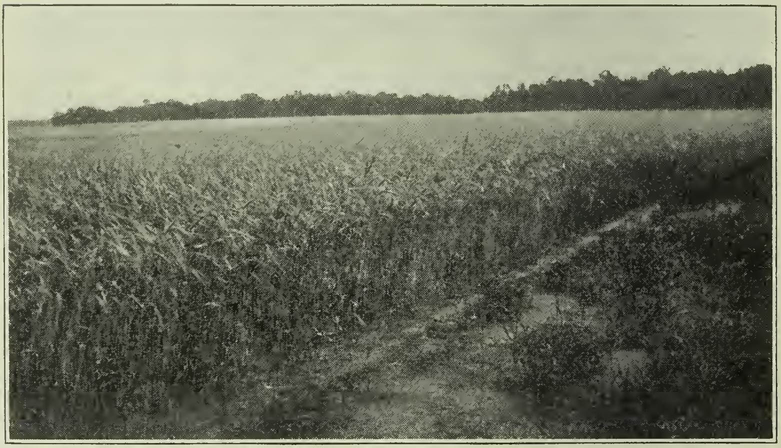
Early fall seeding of rye is preferable to late seeding, for it makes a better cover crop, it takes up more of the available plant food that might otherwise be lost, and it prevents washing during the fall and early spring. In the spring, rye many be used as a pasture, or it may be used as a soiling crop. Often it proves valuable as a green manuring crop to plow under. Because other grain crops do not grow well on sandy soils rye is always relied on for the yearly supply of straw for bedding purposes.

The soil is not prepared, as a general rule, for the seeding of rye, for it seems to be a catch crop and grows well in spite of the haphazard method of seeding. Very often it is seeded at the time of the last cultivation of corn or at the time of digging potatoes, while in other cases the corn field is disked after harvesting and the rye planted. These methods give fairly good results, but it is advisable to prepare the land the same as for other crops to secure a large yield. Disking or rolling fall-sown rye in the spring has materially increased the yield in several tests carried on at different places in the state. The corrugated roller or packer is very efficient for this purpose.

Rye is good for a cover crop, but it may be torn up by windstorms because it lacks the large root system of the legumes. An early seeding makes a better cover crop than a late seeding.



Rye Following Rye



Rye Following a Legume

FIG. 6.—TWO CROPS OF RYE ON SAND

Rye following rye produced 6 bushels an acre,—rye following a legume threshed 15 bushels an acre. Soybeans were plowed under the previous year. The rye needs to be seeded early. (See Figure 1.)

SOYBEANS ON SAND

The soybean, though a southern forage crop, is more resistant to frost than corn, cowpeas, or beans. Varieities have been developed which will grow in any region where corn will mature. The varieties adapted to Wisconsin conditions are: Wisconsin Black, Ito San and Medium Early Green.

The preparation of the seed bed should be about the same as for corn. The seed may either be broadcasted or drilled in rows from 18 inches to 3 feet apart.

The amount of seed required, when planted for seed production, will vary from one-third to one-half bushel to the acre. When planted in drills for hay from one-half to two-thirds of a bushel should be used, the rows being placed 18 to 24 inches apart. If planted in solid drills, one bushel or more will be needed.

Seedings should be made when there is no more danger of frost, because a setback due to cold weather is not easily overcome. The crop requires a growing period of at least two months to be profitable for forage or green manure, but if raised for seed it should be put in not later than the end of May. The seed should be covered with at least an inch of soil and in a very dry season it is best to seed still deeper.

On soil where soybeans have not been grown it is necessary to inoculate if the largest and most profitable crop is to be harvested. Especially is this true on sandy soil. Inoculation makes it possible for the soybean to take the nitrogen of the air and place it in the soil. While adding nitrogen to the soil, the plant is growing more luxuriantly and making a more profitable crop. A pure culture or soil from a field where soybeans have been grown may be used to inoculate the seed.*

If grown for forage, the crop should be cut when the pods are starting to form and should be cured like alfalfa hay. It requires a little more time, however, because the stems are coarser. Or soybeans may be grown between rows of corn and plowed under for green manuring purposes or harvested with the corn and placed in the silo, increasing the feeding value of the silage. In the central and southern parts of Wisconsin soybeans can be planted after harvesting a crop of rye and can be plowed under in the fall as a green manuring crop to enrich the soil in humus and nitrogen.

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* Write for circulars on Soybeans and Inoculation which are distributed free by the Experiment Station, Madison.

To secure the most satisfactory growth of soybeans, lime should be added to the soil. No other crop except clover or alfalfa is adapted to such a variety of uses, and the soybean has the added advantage of sale as a cash crop without removing the plant material from the soil. It can be grown for seed; it is often used for silage with corn in the proportion of one load of soybeans to three or four of corn; it makes excellent hay for all stock; the seed is ground for a concentrated feed similar to oil or cottonseed-meal; the price of the seed when sold is high enough to net a fairly large income. Furthermore, it is very well adapted to most of the poor sandy soils in central Wisconsin and will grow fairly well without special treatment.

Best to Grow Large Soybean Acreage

Every farmer who cultivates poor sandy soil should plant from one-fourth to one-third of his whole farm to soybeans. About one-third of the total acreage planted may be harvested for seed. A portion, as much as the farmer can afford, may be plowed under for green manure and seeded to rye to prepare the field for growing mammoth clover the following year, and the remainder may be used for hay or silage.

Farmers frequently object to purchasing sufficient soybean seed to plant so large an acreage, but a man can easily afford to sell the rye or potato seed which he has on hand and buy soybean seed, for it takes only 20 pounds of soybeans to an acre when they are planted in rows two feet apart.

Another third of the farm may be planted to corn, rye, and potatoes, but the acreage of these crops should be limited as much as is consistent with the money a farmer has and the quality of the soil. On the more fertile or newer sandy soils they may be grown extensively with profit and without material loss of fertility, providing a good rotation including legume crops is used and an adequate return in the form of fertilizers is made. On the poorer soils, legumes should be grown as extensively as possible in order to build up the soil and to permit the farmer to grow more and larger crops of corn and potatoes later.

As large an acreage of clover as the supply of manure and lime will permit should be planted on the remaining portion of the farm. Clover will grow, but starting it needs special attention, and it is wasteful of time and money to plant clover in the ordinary way on much of the light soil of Wisconsin. One ton of clover (dry basis) plowed under is worth as much as five tons of manure in increasing crop yields, a fact which should emphasize the necessity for growing as much clover as the supply of manure and the means for purchasing lime will permit. Great care is necessary to grow a successful crop on soils very low in fertility, but on the better sandy soils it may be grown without difficulty and form the basis for maintaining soil fertility.

VETCH ON SANDY SOILS

There are two distinct varieties of vetch, the spring vetch or tare, and the sand, winter, or hairy vetch. Both varieties are annuals. The spring vetch when used for forage is generally seeded with oats because it has a trailing habit and needs some support. When seeded for green manuring purposes it should be drilled about two inches deep early in spring at the rate of 30 pounds to the acre. The preparation of the seed bed should be about the same as for clover. It is very important that the seed should be covered and the soil compacted with a roller.

Sand, winter, or hairy vetch is seeded in late summer or very early fall, earlier than either fall rye or wheat is seeded. If seeded late it will winterkill severely. If used for green manuring it may be planted between rows of corn at the last cultivation. It may be seeded with rye in the fall and serve as a cover crop over winter, and at the same time help to build up the nitrogen supply in the soil.

Neither spring nor fall vetch will be successful on acid sandy soils without the use of lime. Fall vetch should preferably be used in the rotation with rye on fields where lime is used in the production of clover hay. To secure the best crops of vetch where the field has been limed, the soil may be inoculated, either by the soil or the commercial culture method.

GARDEN AND TRUCK CROPS ON SANDY SOILS

Due to the earliness and the ease with which light soils are cultivated they are especially adapted to the growing of truck and garden crops. Small fruit crops grow very well, providing sufficient fertility is added. Tomatoes, watermelons, canteloupes, lettuce and radishes are most tender and palatable when grown on sand.

To secure the best results with these crops they should be grown in rotation with clover, rather than growing them to the same field every year and depending on heavy applications of manure to keep up the supply of fertility. By rotating with clover many insect enemies and fungous diseases are killed. To produce a good crop in this rotation manure should be applied to the clover. The first crop of clover may be cut and the second plowed under. The following season a commercial fertilizer of nitrogen, phosphorus, and potash may be applied either with another light application of manure or alone.

The composition of the fertilizer will depend largely on the soil. Nitrogen fertilizers should be applied several times during the growing season, making small applications each time to avoid loss.

Where market conditions are favorable, truck farming and small-fruit raising will prove profitable on sandy soils, but they should usually be side issues with dairy farming. Dairying will insure a steady income and a supply of manure for maintaining crop production. Where manure can be bought at a reasonable price, however, dairy farming with truck farming it not necessary.

ALFALFA ON SANDY SOILS

Alfalfa on the poorer sandy soils cannot be recommended very strongly for it does not seem to produce as much hay or benefit the soil as much as mammoth clover. On the better and more fertile sandy soils it makes an excellent growth and produces a fairly large amount of hay of high feeding value. Larger applications of lime are needed for alfalfa than for clover.

Tests with Grimm alfalfa during the last two years have indicated that it is best adapted to the poorer soil. It is more hardy, withstands our severe winters better, and makes a much more rapid growth in spring and after each cutting than the common alfalfa. The principal objection to planting Grimm alfalfa has been the high price of the seed.

The preparation of the soil and the manner and time of seeding are essentially the same as for clover except that the field should be inoculated with soil from an old alfalfa or sweet clover field. About 20 pounds of seed should be used to the acre and the first year the crop should be treated the same as clover. The next year it may be cut for forage two or three times.

If the soil is very low in fertility it is well to apply manure and about 250 pounds of bone-meal and 100 pounds of muriate of potash to an acre in the fall of the second year to help the next year's stand, which may not feel the effect of the first year's application of manure. The third year it should be cropped the same as the second, only that the last crop should be plowed under, thus leaving the field in good fertile and physical condition for such cultivated crops as corn and potatoes. The manure for the cultivated crop may be applied during the winter or spring.

BUCKWHEAT A POOR CROP ON SANDY SOILS

Buckwheat has been grown extensively on the new sandy lands of the state, but it is usually dropped from the rotation after the land has been cropped for a time. It requires considerable organic matter, such as is found in new soil or on marsh lands. It also has a short growing season and will withstand dry weather or drought quite readily. At its best, however, buckwheat is a poor crop to grow on sandy soils for it is very susceptible to frosts in the early fall and to blight during the blossoming stage in midsummer. The yield is usually small and barely pays for the cost of planting and harvesting.

Buckwheat is frequently recommended as a green manuring crop, but experimental work has shown that used thus it causes severe damage to the succeeding crops. Plowing under the coarse buckwheat straw results in a loose open soil which dries out readily. Packing helps to remedy the trouble, but in spite of thorough packing of the soil injurious effects may still be seen on corn following the buckwheat.

SWEET CLOVER ON SANDY SOILS

While sweet clover has made good growth on some sandy soils in the state, it cannot be recommended strongly at present. It does not benefit the soil so much nor grow so well as mammoth clover, and it is not so valuable a feed as alfalfa. Once started on the field sweet clover grows more rapidly than alfalfa, but the difficulty is in securing a good stand. Its habit of growth on roadsides and coal piles leads to the belief that it will grow readily under field conditions, but wherever sweet clover grows on roadsides there is considerable available plant food and the soil is well packed—two conditions which seem essential to the growth of this plant and which cannot be duplicated very easily under field conditions. Soils which are cropped and cultivated do not have the much needed fertility to grow sweet clover successfully, and experiments show that it is more difficult to grow than other legume crops.

SERRADELLA FOR GREEN MANURING

Serradella is an annual legume, which has a very fine stalk and root-system. When well inoculated, large clusters of nodules form on its roots, enabling the plant to fix large quantities of nitrogen. Serradella is particularly valuable as a green manuring crop, and better than any other annual legume fits the soils for producing a larger yield of corn and potatoes.

Serradella thrives best in a moist, cool climate and makes its best growth in the spring or early summer. It is often grown with a nurse crop of oats or rye and after the crop is removed used for green manuring purposes or for pasture. It is as high in protein as alfalfa and the hay is finer and more palatable to livestock. It is an annual and must be planted every year. Inoculation is necessary, but it does not require lime. Serradella is to be used in place of clover only on poor, acid soil where clover will not grow without special attention, as the yield of hay is low.

WHEAT, BARLEY, AND OATS

Wheat and barley are not crops for light sandy soils, for they do not grow well. Oats grow somewhat better, especially on the lands just cleared, or on sandy lands where the fertility has been maintained by the use of manure and fertilizers. Wheat and barley prefer a non-acid soil while oats will grow as well on an acid as on a non-acid soil. Oats are often planted for a hay or a soiling crop on these light soils, but like buckwheat, they do not pay a profit as a cash crop after deducting the cost of planting and harvesting.

COWPEAS ON SANDY SOIL

The cowpea is very similar to the soybean except that it is of vine-like rather than upright habit of growth. It requires the same preparation of seed bed, and is seeded, harvested, and matured in the same way. The hay is more palatable for feed than the soybean, but the seed contains a lower percentage of protein.

The cowpea is not so well adapted to the climatic conditions in Wisconsin as the soybean. It is a southern plant and in hot seasons it grows very well. It can also withstand drought quite readily. It does not need lime and will not be benefited by an application of lime, so it is recommended on acid sandy lands. At the present time, cowpeas are not as strongly advocated as soybeans, but they can be grown profitably in the state and will net a fair return.

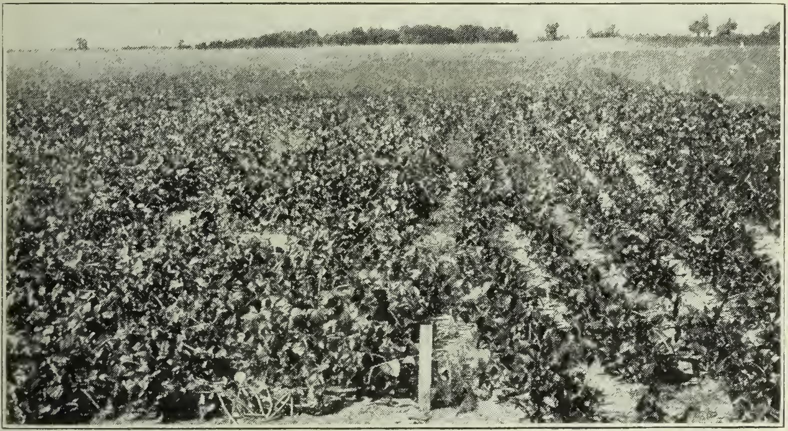

FIG. 7.—INOCULATION MAKES BETTER CROPS

The cowpeas which were inoculated will outyield the uninoculated peas on the other side of the stake. Inoculation means better crops not only of cowpeas but of clover, soybeans, and other legumes as well.

POTATOES

Potatoes are most commonly grown on rather sandy soils because of the better quality resulting and the fact that they are clean when harvested, even though the ground is rather damp. However, potato growing involves a considerable expense for seed and labor and unless the soil is sufficiently fertile and has enough water-holding capacity to produce a fair crop, there is little profit in raising potatoes. Soils which are classified as medium sands are usually too low in water-holding capacity and in fertility to justify the growing of crops which involve so much expense for labor and other items as do potatoes. Fine sands and sandy loams when kept in a good state of fertility will usually produce a sufficient crop of potatoes to justify growing them. But the fertility should be kept at a high stage to make the crop most profitable.

CORN

Corn should be grown more extensively on sandy soils. It grows well if the fertility of the soil is maintained and it can be used for a variety of purposes. Most of it should be used for the silo. Preferably two silos should be filled, one for winter use and one for summer feeding to take the place of pasture. A sufficient acreage of soybeans should be grown to mix with the corn. Corn can also be grown as a cash crop by selecting and selling it for seed. High prices are obtained for seed corn.

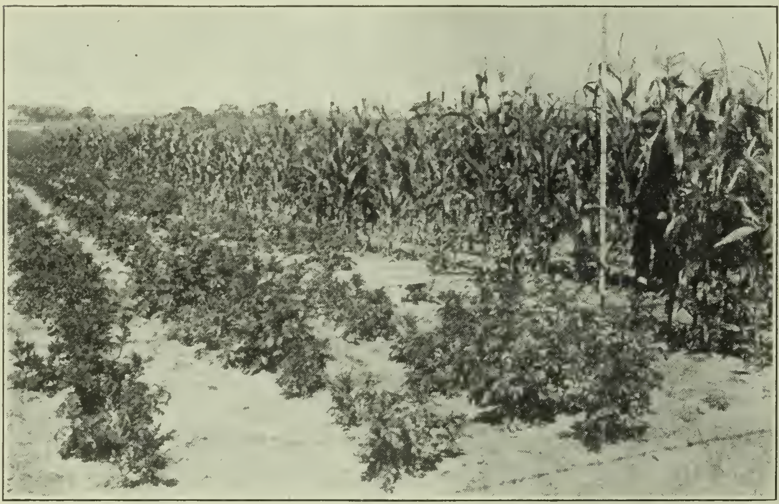

FIG. 8.—FERTILIZERS HELP ON LIGHT SOILS

Commercial fertilizers and manure play important parts in the producing profitable crops on sandy soils. Phosphorus, potash, and limestone were added for this corn and potato crop.

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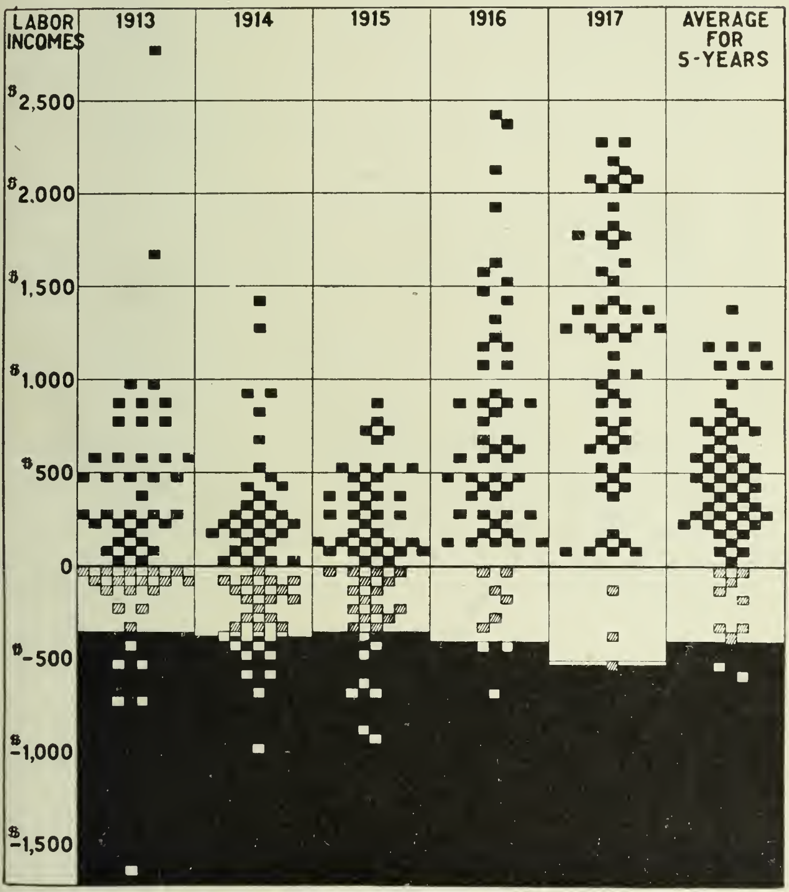
Bulletin 300 March, 1919

War Prices and Farm Profits

H. C. TAYLOR and S. W. MENDUM



THE LABOR INCOMES OF 60 VERONA FARMERS

With war prices most farmers prospered. In 1914 only seven had a labor income of more than $500 in addition to shelter and food furnished by the farm, while in 1917 the number was 46. The farmers whose incomes are indicated by the shaded dots received food and shelter ranging in value up to about $500. The white dots represent the farmers who lost money as well as their time.

AGRICULTURAL EXPERIMENT STATION
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MADISON

DOES FARMING PAY?

Are farmers making too much? Did they make more during the war than usual? What are the rewards from farming? What does an average farmer make? How many farmers just get a bare living from their farms?

A careful reading of this bulletin will help answer these and many other similar questions. It will give definite facts and figures from 60 farms in one community—the community is a typical southern Wisconsin township.

War Prices and Farm Profits

Have farmers reaped a profit from war prices, or have increased expenses absorbed the advantage of higher prices?

Many assertions have been made on each side of this question. What is needed is a closer study of the facts. It is not the purpose of this bulletin to answer this question for American agriculture in general, nor even for Wisconsin farmers as a whole, but to present in simple form the facts as they appear for 60 farms in Dane County, Wisconsin, for the years 1913–1917 inclusive.[1]

In the years 1914 and 1915 both the gross receipts and farm profits fell below the level of 1913. In 1916, the year prior to our entering the war, farm receipts increased appreciably and were followed by a still greater increase in 1917.

In both of these years the expenses increased, but not so rapidly as the income; hence there was an increasing proportion of the gross income left for the farmers' profits or labor income.[1] This is illustrated in Figure 1, which shows the relation of the average receipts, expenses and labor income for the 60 farms covered by the survey for each of the five years.

The study shows that the higher profits of 1916 were due in part to better crops but more largely to higher prices, and that the relatively high returns in 1917 must be attributed entirely to high prices, because the crops were poorer. Figure 2 is drawn to show what the receipts, expenses, and labor income

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[1] In August, 1914, the U. S. Department of Agriculture undertook a continuous farm management survey of the farms in Verona township and a part of Middleton township, Dane County, Wisconsin. Records were then taken from 133 farms for the year March 1, 1913, to March 1, 1914. Four successive sets of records were taken by members of the staff of the Department of Agricultural Economics of the University of Wisconsin, and the results were tabulated by the two agencies jointly. Of over 200 farms visited during the period consecutive records for five years were obtained from 60 farms. The discussion in this bulletin is based on these 60 records, but the representative character of these has been checked by comparing them with the whole number of records taken each year. The average results were approximately the same.

[1] LABOR INCOME is the phrase used to designate what is left for the farmer's labor and managerial ability after deducting from cash receipts and increased inventory all the expenses including an allowance at current rates for the unpaid family labor, depreciation on the equipment, and interest (at 5 per cent) on the value of the farm property. The value of the products consumed by the family and the residence value of the farm house are not included in the income and hence are excluded from labor income in the conventional discussion. The significance of this is indicated in Figure 8.

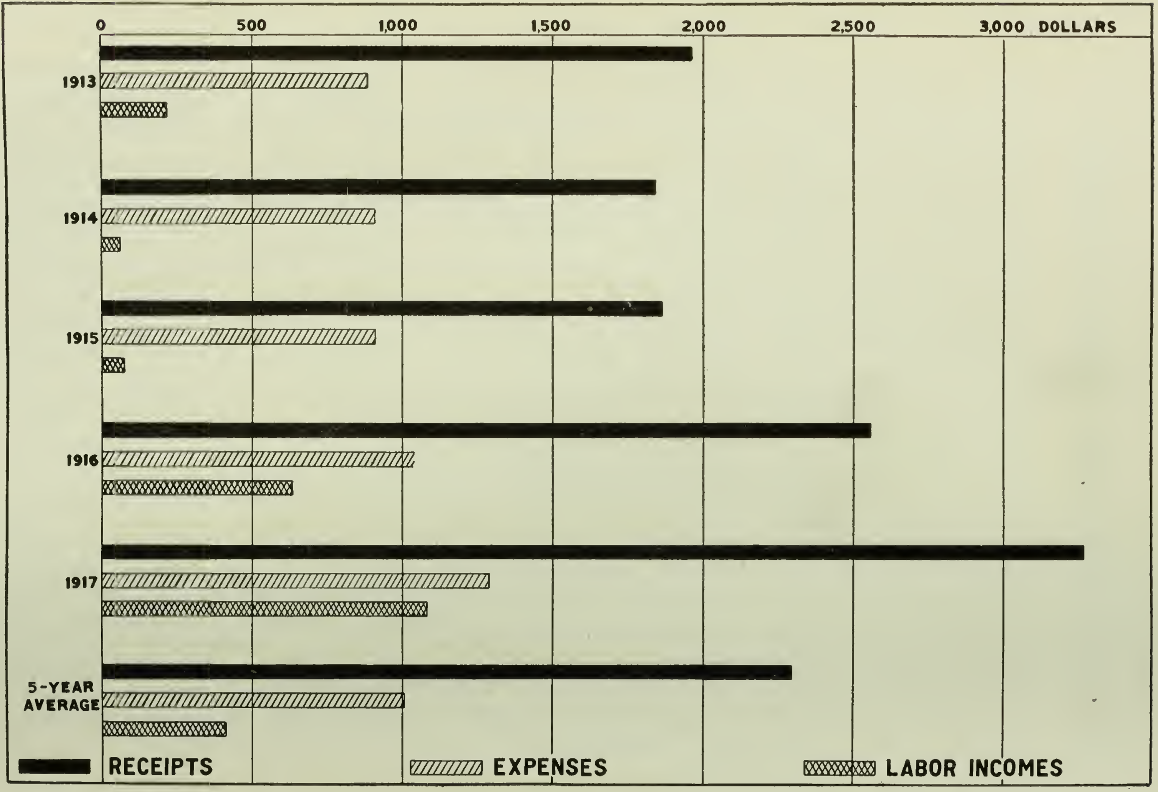

FIG. 1.—LABOR INCOMES INCREASED WITH WAR PRICES

This figure shows the average annual receipts, expenses and labor incomes on 60 Verona farms devoted to dairy and hog

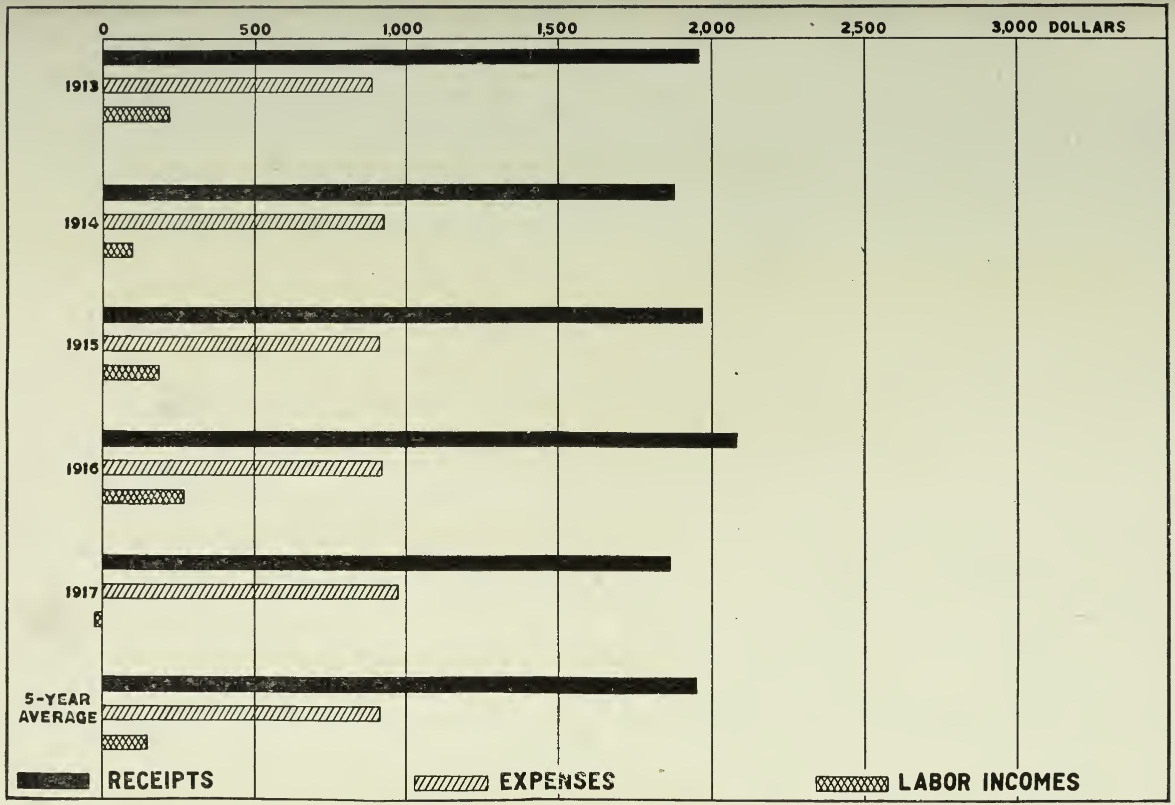

FIG. 2.—WITHOUT WAR PRICES VERONA FARMERS WOULD HAVE HAD A HARD YEAR IN 1917

This chart is drawn on a basis of 1913 prices for products and 1913 rates for the elements of cost, and shows that much of the increased income of 1916 and all of the labor income of 1917 was due to war prices.

would have been on these sixty farms for each of the five years on the assumption of 1913 prices and 1913 rates applied to the elements of cost. Note that on this assumption 1916 would have been slightly better than 1913, while 1917 would have shown a minus labor income. This shows that the profits for 1917 were due entirely to higher prices and not to better crops.

During 1917 prices were high and rising higher, more rapidly than wages and other costs were rising. In this regard 1917 will prove, it is believed, an outstanding year. In 1918 wages and many other elements of cost have risen more rapidly than the prices, and the prospect is for prices to fall more rapidly than costs in the period of reconstruction. This gives none too cheerful an outlook for the farmer; even with such high prices as those of 1916 and 1917 the average labor income for the five years stands at $408. Who would count this too high? But who will guarantee the farmer as good an average for the next five years? It is a matter of great importance to keep a close record of farm finance during the next few years in order that the farming interests may secure a hearing before committees on reconstruction.

The Verona area is more or less typical of the farming conditions in southern Wisconsin. Corn, oats, and hay are the staple crops. Figure 3 shows how nearly equally the crop area is divided among these three crops, and how completely they occupy the tillage land. About 54 per cent of the land is in crops, the remainder is in pasture, woodland and waste land. (See Figure 4.)

The results of the survey of the 60 farms are summarized in Table I, a study of which will show the general nature of the investments, the receipts, expenses, and labor incomes on the average for each of the five years, and the average for the five years. It will be noted that the number of cows increased about 20 per cent during the period. The increase in milk production was due, apparently, to the increase in the number of cows, not to improvement in the quality of the cows.

The main sources of income in the Verona area are dairy products, cattle, and hogs. The percentage of the total receipts received from each source is indicated in Figure 6. It will be noted that receipts from dairy products represented an increasing percentage of the total each of the five years. This was accom-

TABLE I.—SUMMARY OF THE FARM BUSINESS OVER A PERIOD OF FIVE YEARS, 1913—1917, VERONA TOWNSHIP, DANE COUNTY, WIS.

Average of 60 Farms

	1913	1914	1915	1916	1917	5 year ave.
Farm area	149	150	146	147	147	148
Crop area	81.5	80.9	80.2	80.2	80.7	80.7
Months of labor	22.1	22.9	21.5	22.9	23.0	22.5
Number of cows	15.6	16.3	16.5	17.7	18.6	16.9
Number of brood sows	7.6	7.6	6.7	6.2	6.6	6.9
Number of work horses	4.6	4.7	4.7	4.8	4.9	4.7
Investment	$17,307	$17,596	$17.451	$17,803	$18,305	$17,692
Receipts	$1,961	$1,841	$1,858	$2,560	$3,278	$2,300
Divided as follows:						
Sales of crops	81	57	44	74	69	65
Dairy products	826	830	913	1,287	1,743	1,120
Cattle	236	265	322	360	388	314
Hogs	647	547	463	700	911	654
Other stock and stock products	122	102	75	68	77	89
Misc. labor, rent, wood. etc	49	40	41	71	90	58
Expense	882	906	917	1,043	1,288	1,007
Divided as follows:						
Hired labor	143	194	170	183	197	177
Family labor	192	184	175	232	271	211
Repairs	71	71	70	83	91	77
Rough feed	11	3	12	18	28	15
Concentrates: Feed	94	88	122	106	192	120
Taxes and insurance	141	135	138	153	170	147
Depreciation	102	104	109	117	125	111
Misc. current expenses*	128	127	121	151	214	149
Farm income	1,079	935	941	1,517	1,990	1,293
Interest on investment at 5 per cent	865	879	873	891	915	885
Labor income	214	56	68	626	1,075	408
Value operator's labor	401	429	443	479	575	465
Per cent on investment (a)	3.9	2.9	2.9	5.8	7.7	4.7
Farm income	1,079	935	941	1,517	1,990	1,293
Value unpaid family labor	192	185	175	232	276	211
Family income (b)	1,271	1,120	1,116	1,749	2,266	1,504
Family living from farm	351	356	342	388	525	391
Milk production per cow, lbs	4,300	4,550	4,775	4,600	4,350	4,500
Price of milk per cwt	1.23	1.12	1.16	1.58	2.16	1.46
Price of hogs per cwt (c)	7.36	7.36	6.51	8.72	15.73	9.14
Crop yields, per cent of 5 year ave	1.15	1.04	.80	1.09	.93	1.00

*Silo filling, threshing, seed, twine, shoeing. fuel, breeding, veterinary fees, etc.

(a) After deducting value of operator's labor from farm income.

(b) The sum of the farm income and value of unpaid family labor, or the amount available for family living if there is no interest to pay.

(c) Average of October, November. December, farm price given by Monthly Crop Report U. S. D. A., February, 1918.

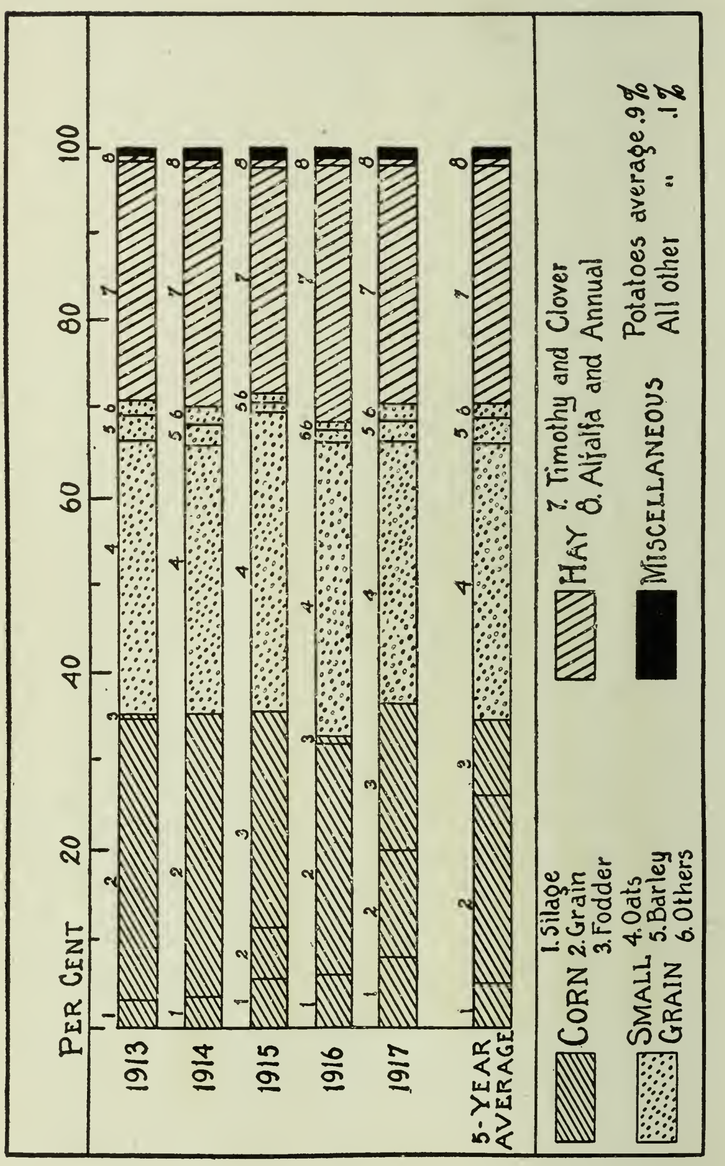

FIG. 3.—CORN, OATS, AND HAY ARE THE LEADING CROPS

This chart shows the relative importance of the various crops grown on the 60 farms.

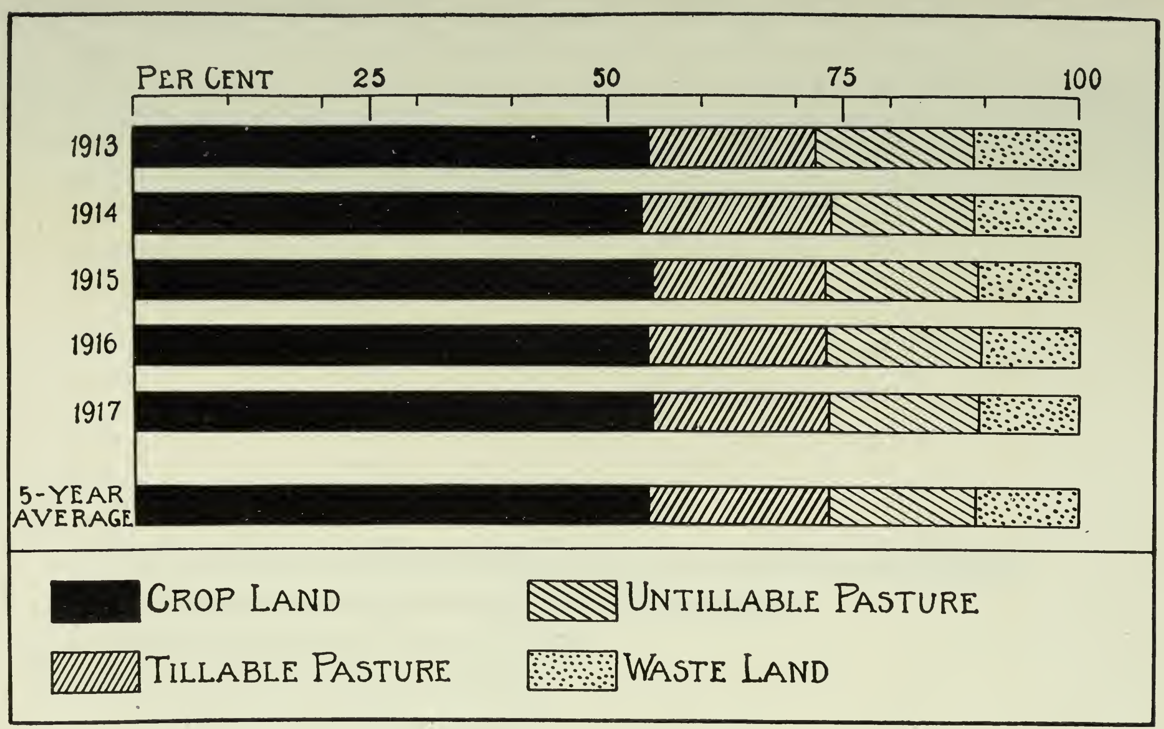

FIG. 4.—USES MADE OF THE LAND ON 60 VERONA FARMS

About one-third of the farm area is pasture land. More than half of the land area is in crops. Pasturage reduces the feed bill.

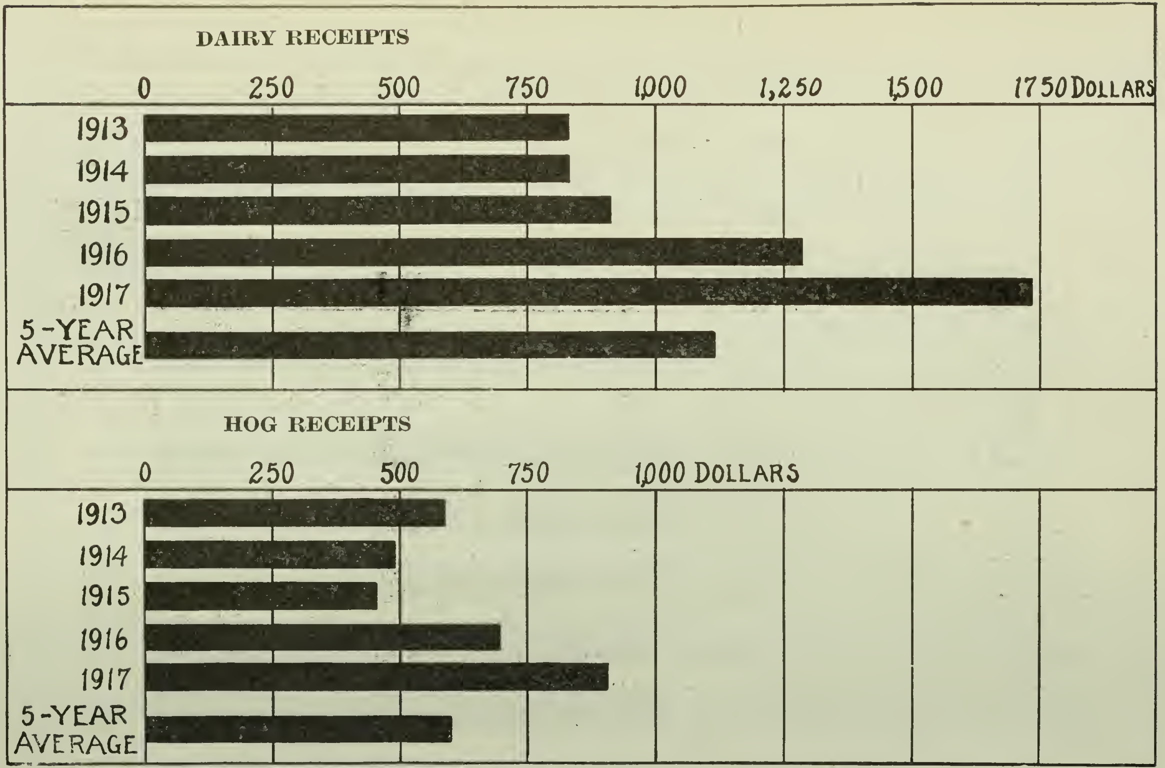

FIG. 5.—RECEIPTS FOR MILK AND FOR HOGS

These figures show the part played by prices in the increased receipts for these products of Verona farms:

Average price per cwt.	1913	1914	1915	1916	1917	Ave.
Milk	$1.22	$1.12	$1.16	$1.58	$2.16	$1.46

panied by an increase in the number of cows and an increase in the number of silos.

The absolute increase in receipts from milk and from hogs is shown in Figure 5. In the years 1914 and 1915, though milk prices were lower than in 1913, there was a slight increase in the receipts from milk. The higher milk prices in the following years resulted in very marked increase in the income from this source. This was accompanied by a like increase from hogs sold in 1916 and 1917 over the receipts in the previous year. These facts point again to the conclusion that the increase in the income was due largely to the rise in prices.

On the other side of the account are the expenses. Figure 1 shows an important increase in the expenses in 1916 and 1917. The percentage of the total expense represented by each of the seven elements of expense is shown in Fig. 7. Note that in spite of the increase in wages hired labor represented a smaller percentage of the total expense in 1917 than in any other of the five years. Note also that feeds purchased represented a higher percentage of the expenses in 1917 than in any other year. This was due to poor crops and an increase in the quantity of feed purchased. Miscellaneous operating expenses, including binder twine, threshing bills, and other items represent a higher percentage of total expenses in 1917 than in any other year.

Figure 8 shows the average gross income for each of the five years, and shows also what becomes of the income. This is at once an expense and an income chart. This chart is more cheering than a study of labor incomes without considering other sources of income which may be available for spending or saving. Commencing at the top of the bars, an estimate of the value of the house rent, fuel, and food furnished the family by the farm is given.[1] Prior to war prices this was more important than labor income, which taken alone certainly looked discouraging in the first three years of the survey. The third item from the top, family labor, is an item which is not paid. This remains in the family pocketbook. It is the fourth item, however, which leaves the farmer feeling prosperous, in the absence of a labor

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[1] In 1913 the U. S. Department of Agriculture made a study of these items for farms in Jefferson County, Wisconsin, and published the findings in Bulletin 410. The figures reported in that bulletin have been recast to fit the conditions in the Verona area for 1913, on the basis that the two communities are similar in many respects. In estimating for the following years of the survey, the index number for "cost of living" (based on 25 food products properly weighted) published by the "Annalist" has been applied to the 1913 figures.

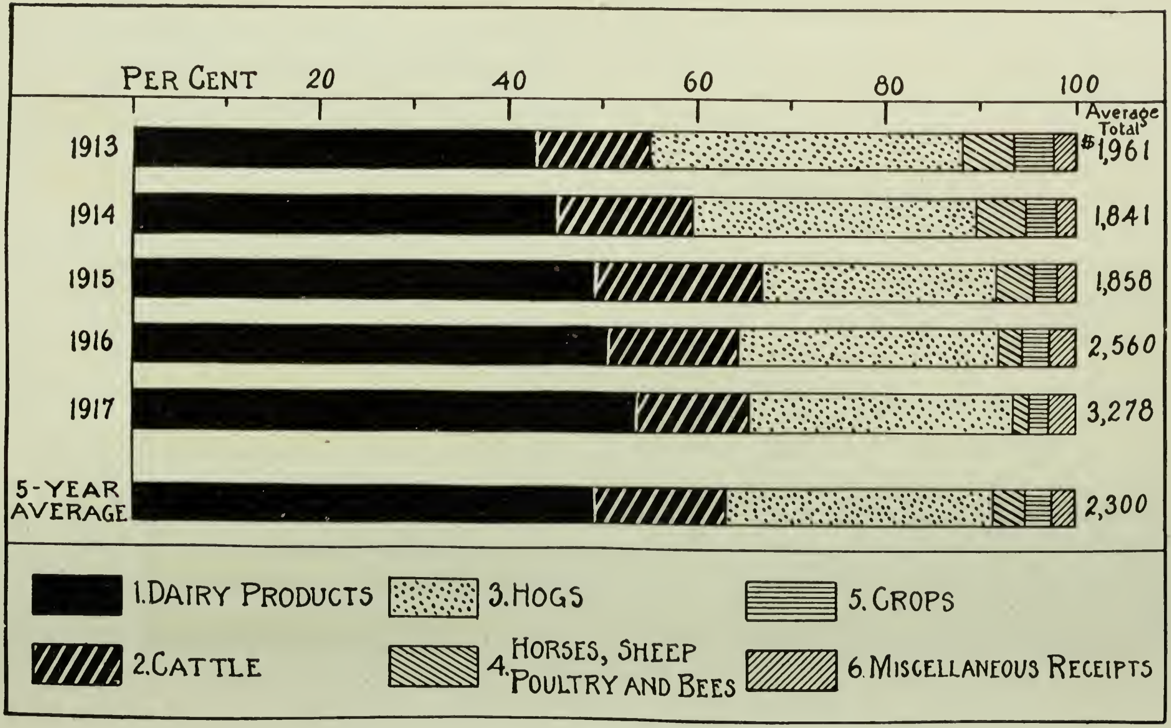

FIG. 6.—COWS AND HOGS BRING THE MONEY

Five-sixths of the income was derived from the dairy herd and hogs.

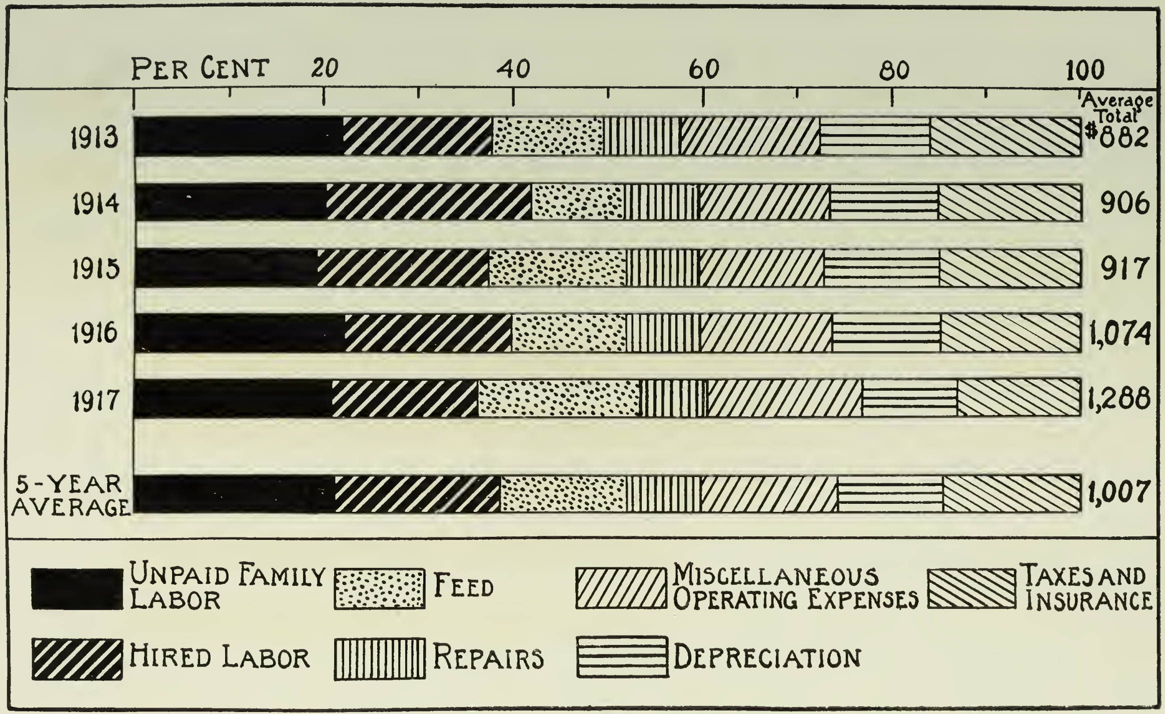

FIG. 7.—DISTRIBUTION OF EXPENSES

While the total expenses increased nearly 50 per cent, the relative importance of the various items changed little except in the case of feeds and miscellaneous items in 1917. These formed only about one-third of the total expense.

income, but only if he is out of debt. If he is heavily in debt, the interest charge is a bill of expense which hangs heavily over the farm family until it is finally stopped by full payment of the debt. Where all of these sources of income are combined, they give the basis of the apparent prosperity of the farmer. Even when he receives small pay for his labor, his disposable income is fairly large.

Figure 9 gives another reason for being hopeful over the farmers' economic outlook. Up to this point, the discussion has dealth wit hthe average of 60 farms. In Figure 9 each of the 60 farmers is given his place on the chart for each of the five years. This shows what skill, energy, and good management can do in the way of winning a handsome labor income at a time when other farmers are losing money. The fact that under most favorable conditions with respect to prices some farmers win no labor income beyond things furnished the family by the farm, helps one to understand why there may be discontent among the farmers when at the same time many farmers are known to be prospering. It is not to be expected that prices will be high enough to give a labor income to the indolent and inefficient, but it is necessary that the industrious, competent farmers be amply paid for their products if the business of farming is to continue to improve.

In farming as in other occupations the prizes are for those who have ability. The wide range in labor income shown in Figure 9 and more accurately arrayed in Table II, gives evidence that the man of skill, industry, and judgment can hope to earn a handsome income by operating a farm.

This is the ground for hope that there will ever be those who can climb the ladder to independence. But with this hope for the man at the head of the class goes the gloomy outlook for the man at the foot of the class.

The number of farmers who made a minus labor income in the years 1913, 1914 and 1915 is entirely too great. On the average for the five years one out of every six farmers netted a loss ranging from $20 to $598, omitting what the family received from the farm. This would seem to be too high a percentage of submerged farmers even with war prices in 1916 and 1917 to bring up the average for the five years. Yet it must be admitted that under the same conditions more than half the farmers made labor incomes which, when combined

TABLE II.—LABOR INCOMES, VERONA AREA

(Arranged according to size of the five-year average)

Rank	Farm No.	5 year average	1913	1914	1915	1916	1917
1	104	$1,337	$865	$1,322	$111	$2,367	$2,018
2	42	1,164	2,773	—376	863	484	2,076
3	65	1,137	869	1,413	517	1,088	1,800
4	39	1,106	469	942	722	1,326	2,070
5	11	1,044	596	449	517	1,460	2,197
6	14	1,010	211	238	57	2,438	2,104
7	56	1,001	908	515	740	842	2,000
8	59	997	869	459	370	1,507	1,780
9	15	874	265	920	67	1,555	1.561
10	69	869	964	—159	510	1,233	1,797
11	96	$777	$411	$677	$690	$892	$1,214
12	58	773	457	—200	223	2.101	1,286
13	48	769	209	155	—54	1,449	2,085
14	129	756	—81	94	772	1,644	1,353
15	46	731	779	—680	—650	1,949	2,255
16	79	703	516	89	120	1.071	1,719
17	1	684	1,619	839	88	—140	1,013
18	109	642	343	188	524	884	1,273
19	137	603	514	—179	—248	1,174	1,756
20	110	598	—50	—302	270	1.166	1,907
21	44	$565	$201	$ 31	$ 97	$196	$2,298
22	106	557	777	324	121	262	1,299
23	4	529	236	21	277	857	1,255
24	108	524	224	142	250	795	1,210
25	71	512	112	378	369	561	1,141
26	113	468	424	—151	128	567	1,374
27	82	456	779	247	—256	587	924
28	83	441	528	263	185	611	618
29	135	421	—27	—269	310	679	1.411
30	7	416	7	254	—87	384	1,522
31	23	$402	$266	$302	$472	$274	$694
32	18	367	552	—55	24	669	647
33	17	349	283	159	—56	483	874
34	105	342	—714	—455	368	875	1,634
35	90	331	—50	—72	88	647	1,041
36	50	313	236	156	—46	430	790
37	111	252	69	13	3	490	684
38	77	246	30	—117	—176	102	1.391
39	80	239	1	—365	294	407	858
40	134	233	—98	148	162	—13	968
41	107	$221	$417	$249	$—49	$—41	530
42	10	206	196	417	—227	260	384
43	84	201	—17	199	—102	117	708
44	61	192	—201	—406	—363	540	1,390
45	29	182	—50	—91	360	286	406
46	102	175	—188	220	—146	194	797
47	36	137	158	—149	423	130	122
48	130	98	—45	—115	109	478	64
49	95	39	—38	24	—204	217	197
50	5	22	—129	—457	485	103	109
51	$2	—$20	—$118	$—94	$—340	$357	$ 93
52	21	—37	—5	—266	—308	—152	547
53	33	—57	11	—48	—258	—410	420
54	122	—100	—301	—330	—47	102	77
55	87	—161	—531	—591	—687	910	93
56	12	—310	—567	—386	—637	—443	481
57	72	—315	—275	—434	—423	—312	—131
58	94	—347	—1,584	—317	—927	—162	1,253
59	121	—593	—490	—964	—455	—660	—397
60	93	—598	—747	—574	—866	—267	—534
Total		$24,483	$12,838	$3,345	$4,074	$37,650	$64,506
Average	60 farms	408	214	56	68	626	1,075
Maximum		$1,337	$2,773	$1,413	$863	$2.438	$2,298
Minimum		—598	—1.584	—964	—927	—660	—534
Range		1.935	4.357	2,377	1,790	3.098	2.832
Index		1.00	.52	.14	.17	1.54	2.64

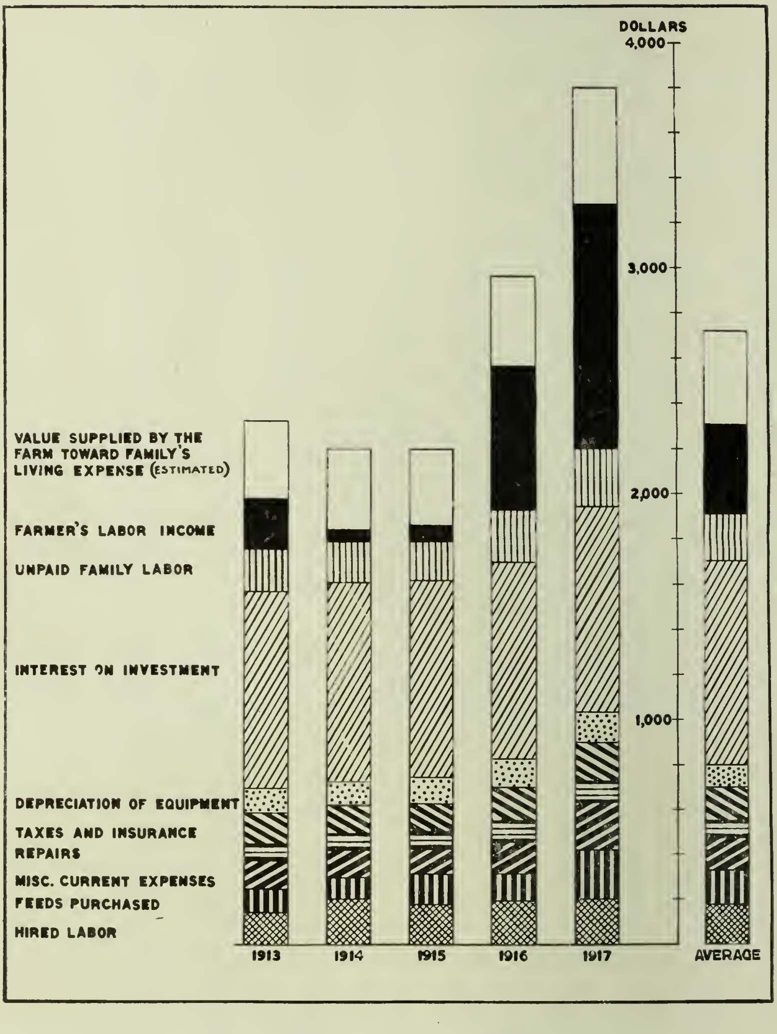

FIG. 8.—WHERE DOES THE MONEY GO?

This distribution of gross income explains the apparent prosperity of farmers, even when conditions are such that their own wages (labor incomes) are very small. If the farmer is free from debt the family may have a large income to dispose of.

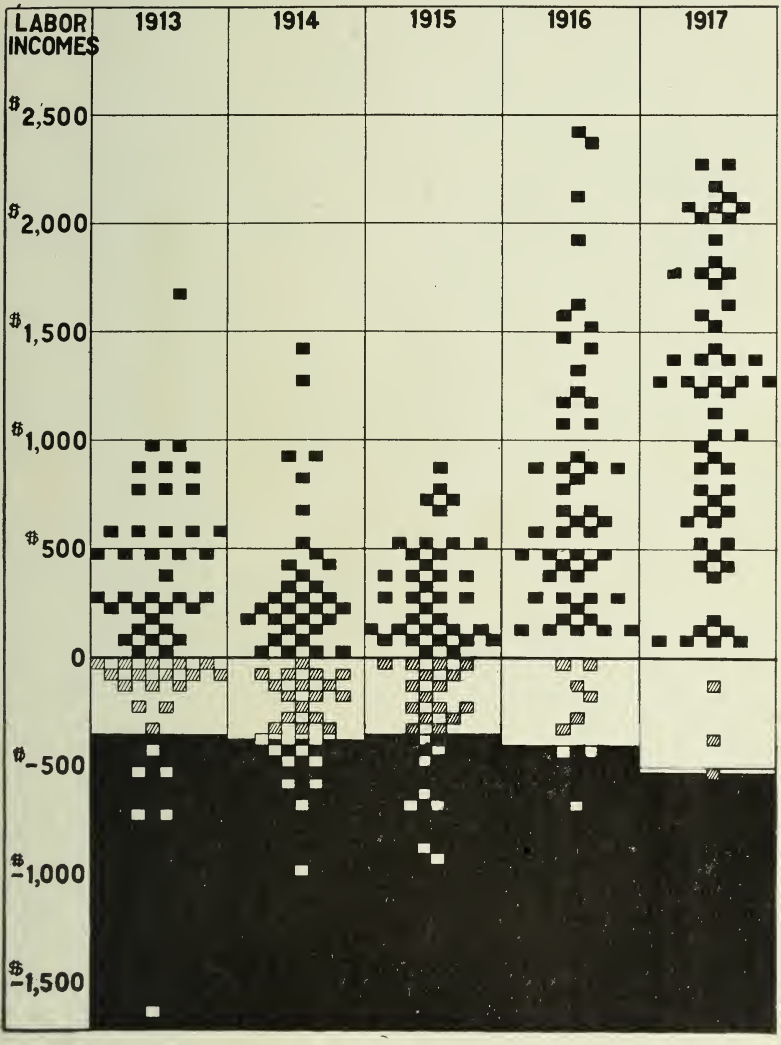

FIG. 9.—WITH FAIR PRICES THE FARMER'S OUTLOOK IS HOPEFUL

Each dot in this figure represents the labor income of one farmer. The grouping of the dots tends to follow the trend of prices of products. Farmers represented by dots lying between the black area and the zero line had to be content with interest and a part of their living from the farm. Those in the black area did not make interest on their investment, to say nothing of wages for their labor.

with what the farm furnished the family, put them in a position to get ahead financially year after year. The future of American agriculture demands that the road be kept open to the top. A high percentage of the young farmers must be able to save from their earnings and buy farms. This requires adequate prices, and while there is no law of human justice which demands that prices be so high that the man without ability and willingness to work successfully under his own guidance shall be made to flourish as the manager of a farm, prices should be high enough to give at least five out of six a labor income. It took the prices of 1916 and 1917 to bring the Verona farmers up to this level and to give them a five-year average labor income of $408.

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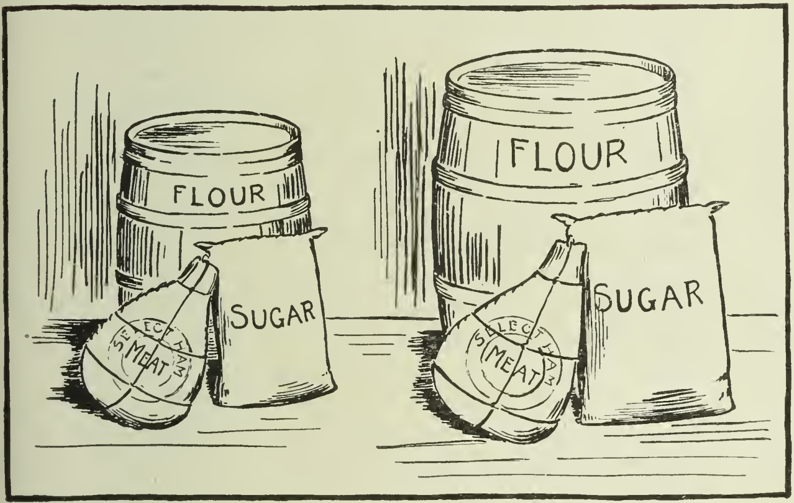
Bulletin 301 April, 1919

Wisconsin Wins

Annual Report of the Agricultural Extension Service for 1917--18

H. L. RUSSELL and K. L. HATCH



1917 1918

WISCONSIN'S MAJOR CONTRIBUTION

Teamwork was responsible for the state's remarkable record in increasing the production of bread cereals 60 per cent, sugar beets 30 per cent, meat 20 per cent and other products in a similar manner.

EXTENSION SERVICE OF THE COLLEGE OF AGRICULTURE
THE UNIVERSITY OF WISCONSIN

MADISON

What the Agricultural Extension Service Will do for You

Find a market for your surplus dairy cattle.
Help find suitable pure bred sires for you.
Organize a cow testing association in your neighborhood.
Plan economical rations for your live stock.
Show you how to select the laying hens.
Prove the value of pure bred seeds.
Demonstrate how to succeed with alfalfa.
Send inoculation for your legumes.
Show you how to control smut, blight, and barley stripe.
Prescribe for your other plant diseases.
Tell you how best to fight bugs and insects.
Illustrate how to produce fruit free from defects.
Select pure strains of potatoes and certify the seed.
Help you to drain that wet spot.
Test your soil and prescribe helpful fertilizers.
Clear new land with less backache.
Send you plans for farm buildings.
Show you how to beautify your farm grounds cheaply.
Suggest helpful conveniences for the farm home.
Help you to improve the quality of your dairy products.
Show you how to keep farm accounts.
Form Boys' and Girls' Clubs for your children.
Assist Farmers' Clubs and Cooperative Organizations.
Arrange a Farmers' Meeting for your neighborhood.
Send you FREE bulletins and circulars.

For "First Aid" See Your County Agent

Wisconsin Wins

''Food will win the war'' was the slogan of every patriotic farmer during 1918. All the energies of leadership possessed by the College of Agriculture were bent toward the end of ''More Food.'' Despite the serious handicap of farm labor shortage, particularly acute with the advance of the harvest season, Wisconsin made an enviable record, though the physical strength of her farm population was taxed to the utmost.

TEAM WORK EFFECTIVE

In no other state do all its agencies work together for the common good better than in Wisconsin. The success of the food production campaign was in no small degree due to the excellent team work of all federal, state and county agencies. The entire program was under direction of the State Council of Defense, working through the county council organizations, particularly their agricultural committees composed of the leading patriotic farmers of the county.

The U. S. Department of Agriculture, the Wisconsin Department of Agriculture, the Wisconsin Live Stock Breeders' Association, the Wisconsin Dairymens' Association, the various state and county breeders' associations, the Wisconsin Experiment Association and the State Horticultural Society—all united with the College of Agriculture in the planning and execution of the food production campaign to achieve these ends:

First, to produce more of the essential vegetable foods, such as potatoes, sugar and bread cereals.

Second, to increase the supply of fats and animal foods, including poultry, beef, pork, milk and other dairy products.

Third, to make each acre produce more of feed for animals and of food for man, through the use of better seed, better crops, weed eradication and soil management.

Fourth, to bring more acres under cultivation through drainage, land clearing and the control of weeds, plant diseases and insect pests.

BADGERS BOOST BREAD

In no other instance were such phenomenal results obtained as in the bread grain drive. The acreage of wheat and rye was greatly increased and the total bread harvest was boosted in a single year from 10,000,000 to nearly 16,000,000 bushels!

FIG. 2.—THE WISCONSIN PORKER GREW

In reply to the appeal for more meat and fat, the 2,019,000 hogs weighing about 200,000 tons in 1917, were increased to 2,180,000 head, weighing 240,000 tons, in 1918.

This was due to the fixed price for wheat, the use of purebred seed, an unusually favorable season, the patriotic impulse and the splendid cooperation which the agronomy department secured with the Wisconsin millers and bankers.

PIGS MAKE PORK

Pigs and poultry offered promise of quick returns in the effort to relieve the shortage of meats but the destruction of the corn crop by the frost of 1917 forced a reduction in the supply of Wisconsin pork products for that year. This shortage was met with the "Extra Litter" campaign of 1918 which resulted in an increase of 7 per cent over the previous year. The additional supply of good corn enabled the farmers to market these hogs showing a gain of 18 per cent in weight over the previous year. Thus, 20 per cent was added to the state's supply of fat. The largest single factor in this campaign was, without doubt the now familiar 13 to 1 ratio of the food administration which furnished the necessary financial incentive to make the effort worth while.

WAR GARDEN WORK

Early in the year plans were made by the horticulture department to wage a vigorous campaign for the production of war gardens. Through lectures and printed matter practically every person in the various cities of the state was reached and the number of war gardens planted added in no small degree to the food insurance of the state.

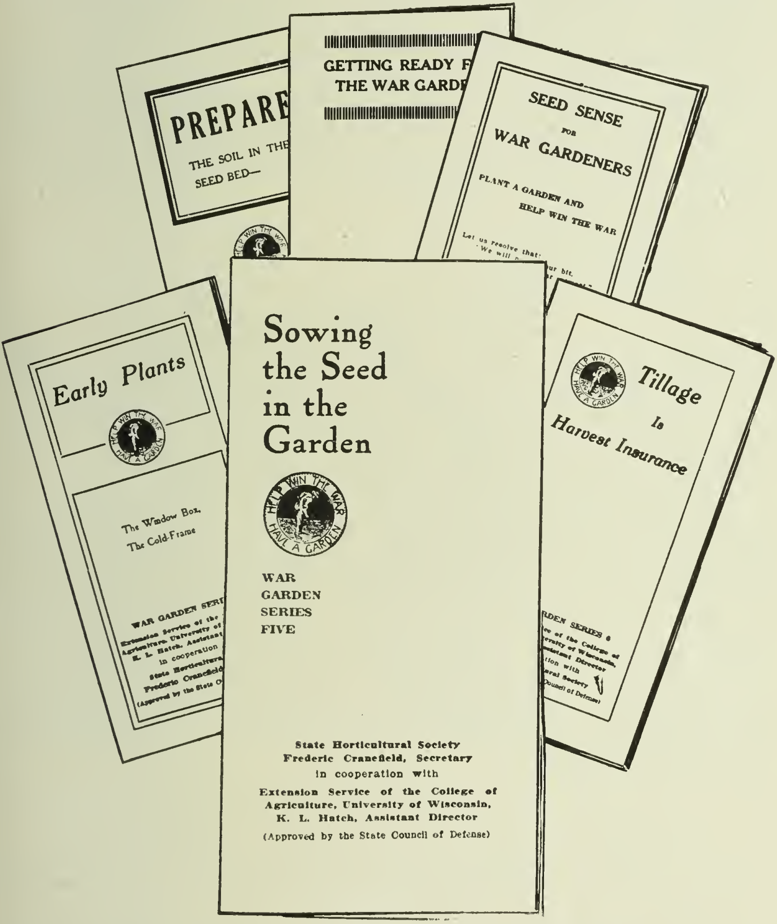


FIG. 3.—AMMUNITION FOR THE VICTORY GARDENS

Thousands of attractive folders were issued to meet the needs of the enthusiastic "back lotters."

THE POTATO PROBLEM SOLVED

The large potato crop of 1917 and the consequent slump in prices just before planting time made vigorous measures necessary to prevent a reduction in acreage. Through general publicity, the patriotic appeal, the holding of meetings and conferences in the potato sections, boys' and girls' potato clubs and the activity of the State Council of Defense in assisting farmers to find markets for their surplus stock, the usual Wisconsin acreage was maintained. With favorable weather a bumper crop was the result.

SWEETS SHORTAGE RELIEVED

When the call came for more sugar a systematic campaign was undertaken to increase the sugar beet acreage in the vicinity of the sugar beet factories and within easy access of loading stations. ''Raise Your Own Sugar'' was the slogan.

Twenty-five per cent was added to the acreage planted to sugar beets and conditions now indicate an increase of more than 30 per cent in the beet-sugar output of the state. On the basis of the restricted allotment of the U. S. Food Administration, Wisconsin raised enough sugar to supply her own needs and to assist in relieving serious shortage elsewhere.

Besides this, sorghum growing was revived and a sufficient acreage planted to keep all available sorghum mills busy during the grinding season.

CORN FOR FEED AND FLOUR

Owing to the early freeze the corn crop of 1917 was very poor. Hardly any of it matured for seed. This made the seed corn situation serious. A seed corn survey taken early in the spring by the schools revealed a shortage of approximately 100,000 bushels. The State Seed Stocks Committee was able to supply farmers with adequate seed from outside the state and to secure redistribution of locally grown purebred stocks so that normal acreage was slightly increased. The quality of the crop this year proved exceptionally good for use as flour, feed and silage.

SILO DRIVE SUCCESSFUL

The silo drive, pushed with vigor last year was continued. Despite a shortage of material and restricted transportation a very substantial increase was made in the number of silos already popular on Wisconsin farms.

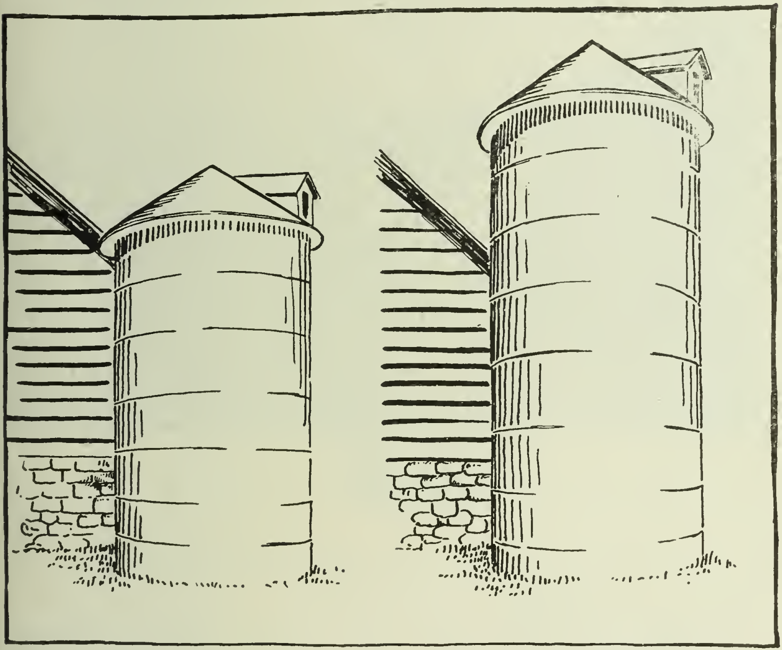


FIG. 4.—WISCONSIN FARMERS BUILT 10,000 SILOS IN WAR TIME

In the spring of 1917 the state had 58,000 silos in which to store succulent feed. By fall of 1918, 68,000 silos were serving.

POULTRY PROVES PRODUCTION

During the year the production of more poultry was actively pushed by the formation of poultry clubs, by lectures, and demonstration given by the poultry department and representatives of the U. S. Department of Agriculture and by the use of press and educational material. The results are shown in the increased supply of Wisconsin poultry and eggs received at the Milwaukee and Chicago markets and by a net increase of 12 per cent in the poultry production of the state.

FIG. 5.—ABOUT TO LEAVE WISCONSIN

A small part of the million dollars worth of dairy cattle sold to other states in 1918.

DAIRY CATTLE DISTRIBUTION SPEEDS UP

The plan for dairy cattle redistribution, employed last year, has developed both in proportions and future promise. Not a week passed but from one to twenty buyers visited the state for the purpose of obtaining purebred, or high-grade dairy cattle. The Extension Service with the cooperation of the various live stock breeders' associations has assisted in the transfer of more than $1,000,000 worth of dairy cattle to out-of-state buyers in the last year.

No doubt the high price of dairy products during the war has accelerated the movement of dairy cattle. It must be remembered, however, that with the coming of peace and a restoration of our reserve supply of grain, great areas in the Northwest, West and Southwest now devoted to grain and cotton growing will be forced to more intensive agriculture. In such a system dairy farming is certain to occupy a very important place. Nor is this all. The whole milk business demands a

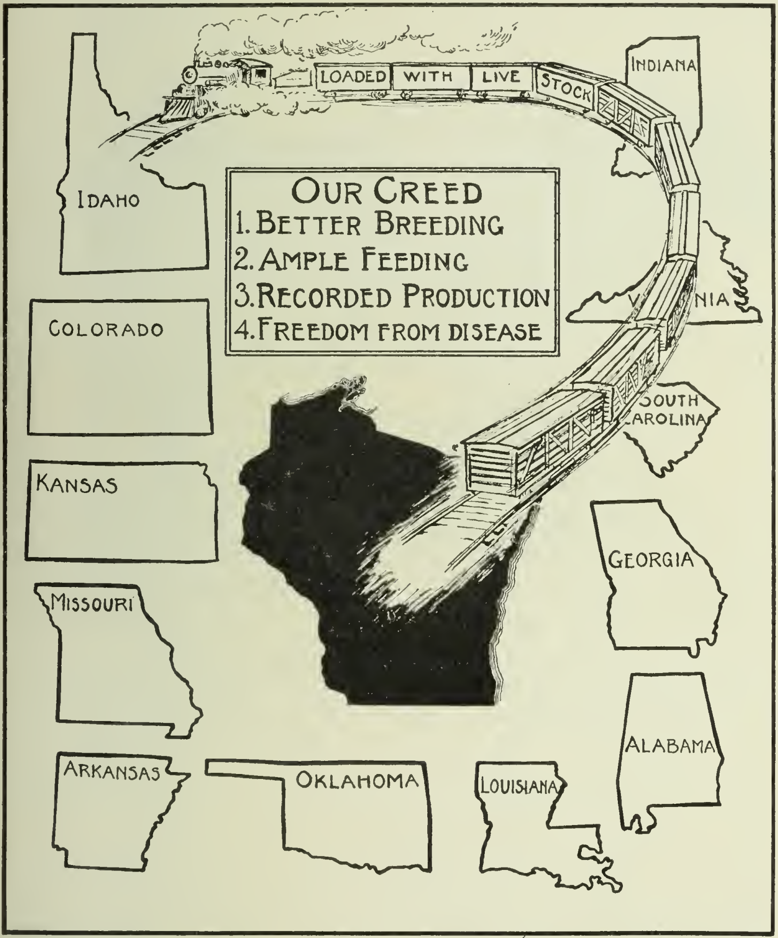


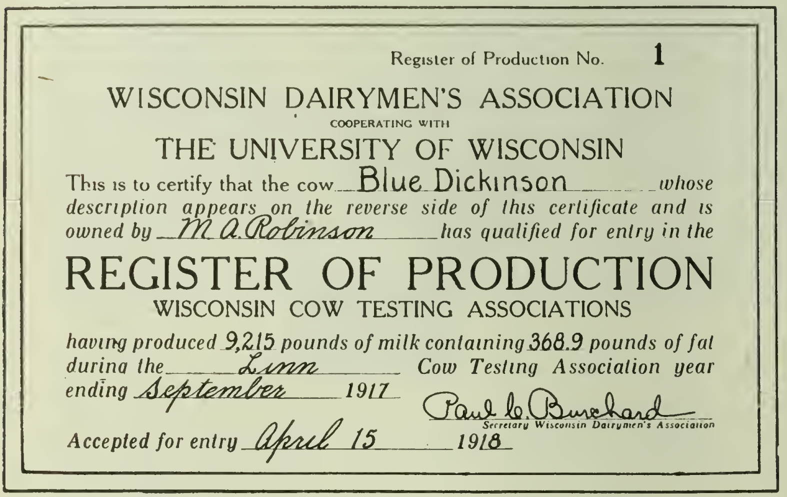
FIG. 6.—WHAT "OUR CREED" HAS MEANT TO OTHER STATES

Outside markets were supplied through the Extension Service with more than 400 car loads of Wisconsin dairy cattle during the past year.

constant supply of new animals to take the place of discarded cows. Since in most milk supply sections not enough calves are raised the redistribution of dairy cattle is bound to be of ever increasing importance.

ASSOCIATION RECORDS PROVED PROFITABLE

That a favorable yearly record adds from $10 to $25 to the market value of a cow and a proportionate amount to the price of her daughters is amply proven by the eagerness of buyers to pay a premium for cows and heifers from tested herds. The new "Register of Production" of cows whose yearly association records show an average of a "pound a day," or 365 pounds for the year, is proving particularly helpful in encouraging the further testing of Wisconsin herds. While this has been in operation only a few months its value has already been proven beyond question. The 46 new associations added during the year bring the total number of cows placed under test up to 54,661 or an increase of 50 per cent over last year. Owing to



Register of Production No. 1

WISCONSIN DAIRYMEN'S ASSOCIATION

COOPERATING WITH

THE UNIVERSITY OF WISCONSIN

This is to certify that the cow Blue Dickinson whose *description appears on the reverse side of this certificate and is owned by* M. A. Robinson *has qualified for entry in the*

REGISTER OF PRODUCTION

WISCONSIN COW TESTING ASSOCIATIONS

having produced 9,215 *pounds of milk containing* 368.9 *pounds of fat during the* Linn *Cow Testing Association year ending* September *1917*

Paul C. Burchard
Secretary Wisconsin Dairymen's Association

Accepted for entry April 15 *1918*

FIG. 7.—CERTIFICATES LIKE THIS ADD TO VALUE

Every cow that makes an association record of a "pound a day" or 365 pounds of fat during the year is entitled to one of these certificates.

the need for men in military affairs it was impossible to keep all these associations supplied with competent testers. This has had the effect of reducing considerably the number of cows now under test.

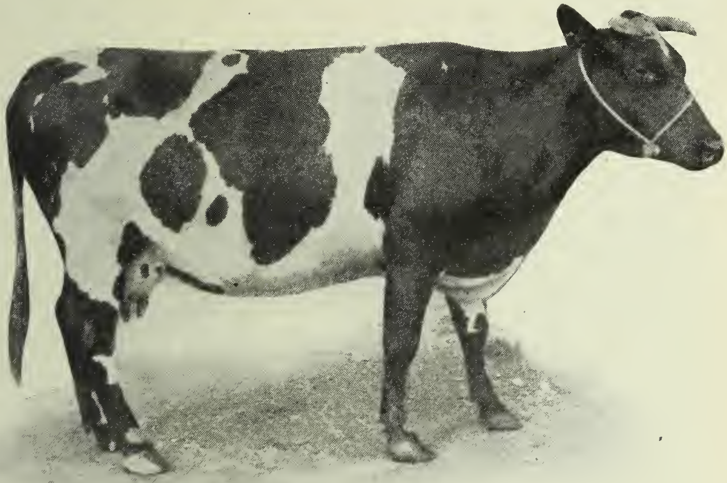


FIG. 8.—SOLD FOR MERIT, NOT MARKS

The buyer was not interested in this cow until he learned that the cow testing association record showed a net gain of $99—above feed costs. Then he paid an extra $25 to get her.

ALFALFA REPLACES BRAN

The value of alfalfa as a dairy feed was especially emphasized by the shortage of bran and other mill feeds. In Green County a group of farmers imported 375 tons through the alfalfa organization. Its proved value has lent more than ordinary interest to the 390 demonstration plats that have been established through the state by Mr. Graber (Agronomy) during the last three years.

FERTILIZERS PRODUCE FOOD

While "food wins war" it takes fertility to produce food. Legumes will not do their best on poor land, neither will bread grains yield a maximum crop in a soil low in phosphorus or potash. Even under the handicap of high prices, demonstration work by the soils department on the use of fertilizers and lime showed a profit in their use—as well as a very material increase in the food stuffs so badly needed. The export of large quantities of grain will lower the available fertility of our farms to an extent that will necessitate more careful management of our soils and a more liberal use of fertilizers in the immediate future if soil fertility is to be properly maintained.

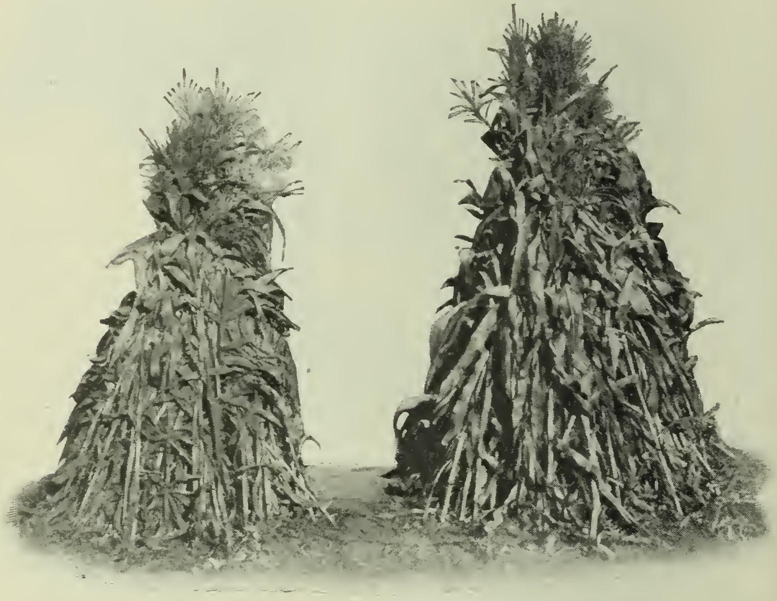


FIG. 9.—HERE FERTILIZER DOUBLED THE YIELD

Each shock was grown on one square rod of long cropped silt loam. The corn on the unfertilized plot yielded at the rate of 8.7 tons an acre while the fertilized plot yielded 15.8 tons, or nearly twice as much silage, at a cost of $1.70 an acre for fertilizer.

KILL THE PESTS AND SAVE THE CROP

Systematic effort to destroy weeds, grain diseases and insect pests during the past year resulted in the saving of hundreds of thousands of bushels of grain. The common barberry, the host plant for wheat rust, was persistently fought. Very little rust appeared and as a result the yield of spring wheat was exceptionally good. Seed treatment for smut in oats, ergot in rye and barley stripe was consistently practiced under the leadership of the plant pathology department by federal, state and county agents. Over 6,390 bushels were treated by four agents, nearly 1600 bushels each.

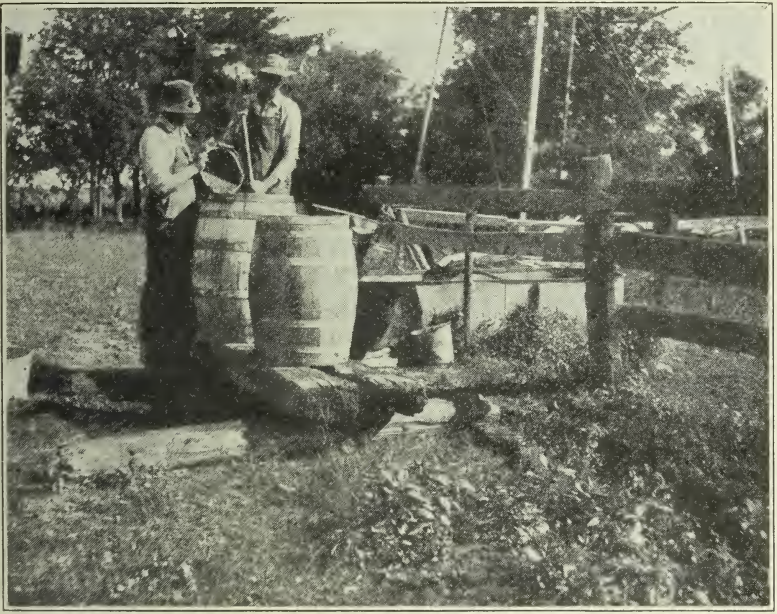


FIG. 10.—REMOVING ERGOT FROM RYE

The diseased rye kernels float in a strong brine solution and are easily skimmed off, leaving the sound kernels for seed.

Crop rotation, frequent cultivation and the use of cleaned and treated seeds, free from weeds, were the general methods adopted for the control of all pests.

An outbreak of late potato blight in Barron County was quickly brought under control and its spread effectively prevented. Similarly, orchard pruning and spraying demonstrations and apple grading and packing at 41 different places in the state carried on by the horticulture department proved of value both in saving the fruit crop and in marketing it to good advantage.

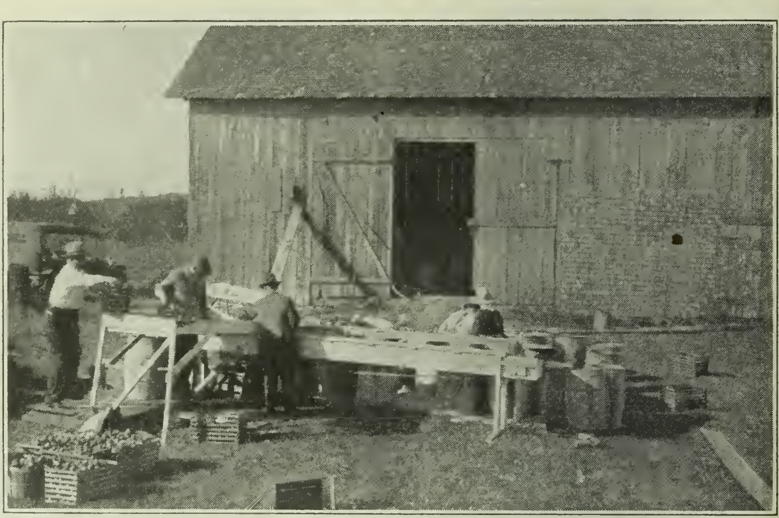


FIG. 11.—APPLE GRADING AND PACKING AIDS IN PROFITABLE MARKETING

Assisting the State Department of Agriculture to demonstrate the proper grading and packing of apples under the new apple grading law.

INOCULATION INCREASES YIELDS

During the spring of 1918 cultures for the inoculation of approximately 7000 acres of common legumes were supplied by the bacteriology department. Reports indicate that the cultures produced increased yields in 90 per cent of the cases of alfalfa and soybeans.

THRESHERMEN SAVE GRAIN

Over 200,000 bushels of bread grains were saved as a direct result of the educational work of the grain threshing committees organized by the food administration with the assistance of county agents and local threshermen.

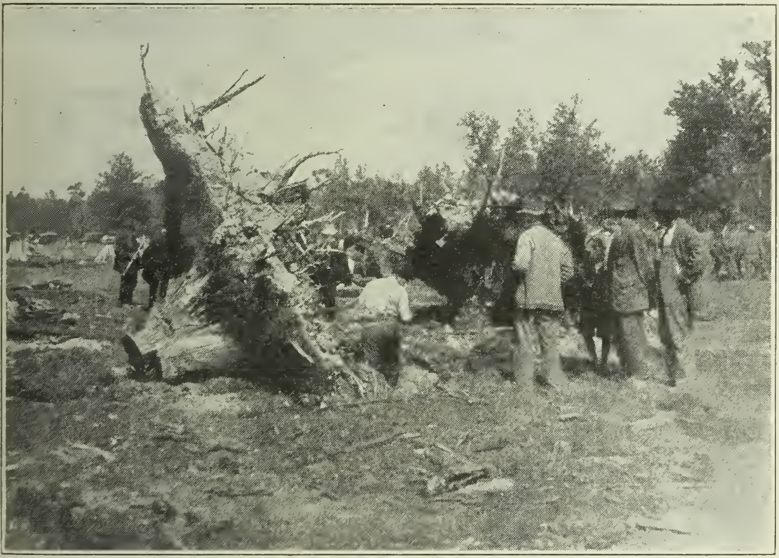


FIG. 12.—FINDING AN EASIER AND QUICKER WAY

The Land Clearing Special, under special permit from the United States Railroad Administration, was run as a part of the plan for putting more fertile land under the plow.

BRUSH VS. BREAD

Land clearing demonstrations and brushing contests, participated in by upwards of 15,000 people, aroused many an idle acre to war activity. In Sawyer County alone, 30 per cent was added to the cultivated area and a corresponding amount to the total yield of food products. This is typical of the progress made in a number of the counties of the northern section and was without doubt greatly stimulated by the educational work of the agricultural college. The "Land Clearing Special," the only demonstration train authorized last year by the U. S.

Railroad administration, greatly stimulated activity in land clearing operations.

WET LAND SET TO WORK

The drainage of small wet spots on 97 farms urged by the agricultural engineering department reclaimed 1800 acres during the past year. The work was done principally on land just dry enough to tempt the farmer to cultivate it, but just wet enough to prevent the growth of a crop. In almost every enterprise of this sort the entire crop can be considered as net profit, since in former years such land was generally cultivated without any adequate return on account of poor drainage.

SERVICE FROM SAVING

At the time of the most serious food shortage it was of the greatest importance to save. Both food and clothing were badly needed by our armies and allies and the supply had to come from stocks on hand. Economy was the watchword. To teach and to preach economy, 20 home demonstration agents were located in as many counties of the state. Their work was on the use of wheat substitutes, in the manufacture of war breads, in the saving of sugar and fat, in the conservation of clothing by making over old garments and in health and general welfare problems, so largely fostered by the home economics department.

This work was so varied in character, so wide in its scope and so incapable of measurement from statistical data available, that it is impossible to give even an approximate estimate of its economic return. That the food and clothing crisis was met and passed without serious suffering is sufficient evidence of its value.

Another aspect of this work was the "cottage cheese campaign." This work, directed by the dairy department, stimulated the consumption of cottage cheese, a by-product of the dairy industry, and partially utilized for human food an over supply of skimmilk which always obtains during the flush season of the year in the principal distributing centers.

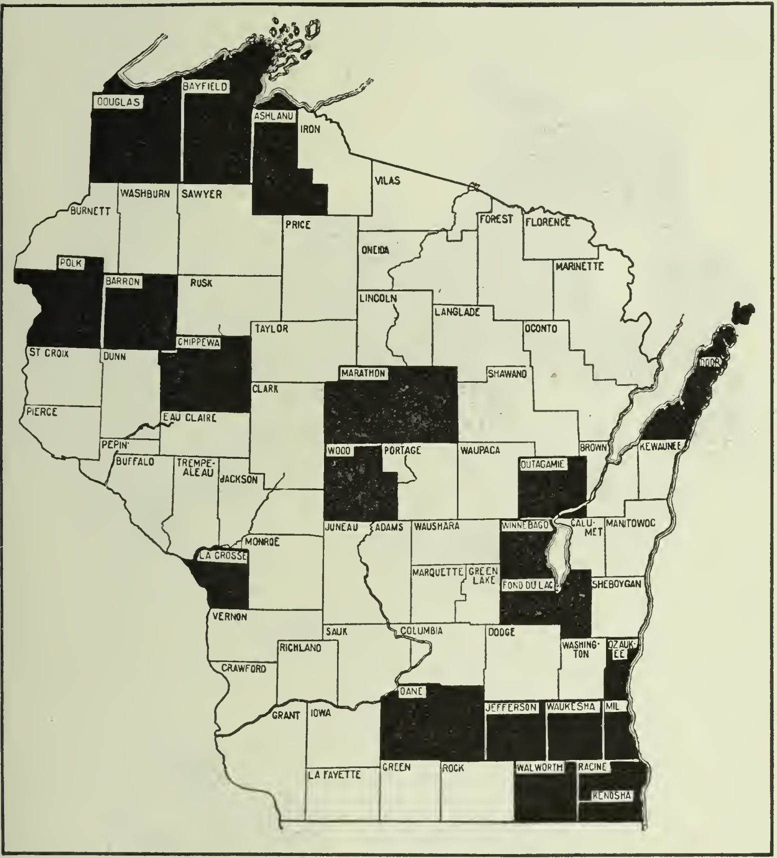


FIG. 13.—WHERE HOME DEMONSTRATION AGENTS HELPED

Women agents were active in a third of the counties in the conservation drive.

COUNTY AGENTS CARRY LOAD

To carry out the food production program it was necessary to have active leaders in all parts of the state. To this end the county representative system was more completely developed.

Emergency food agents were supplied from special funds set aside by Congress under the terms of the Food Stimulation Act.

The College of Agriculture sent many of its students into the fields prior to the passage of the draft act, thus releasing its professors to take up emergency work in the counties not supplied with regular county agents. Hence, less than a month after the outbreak of the war found the agricultural forces already mobilized for active field service.

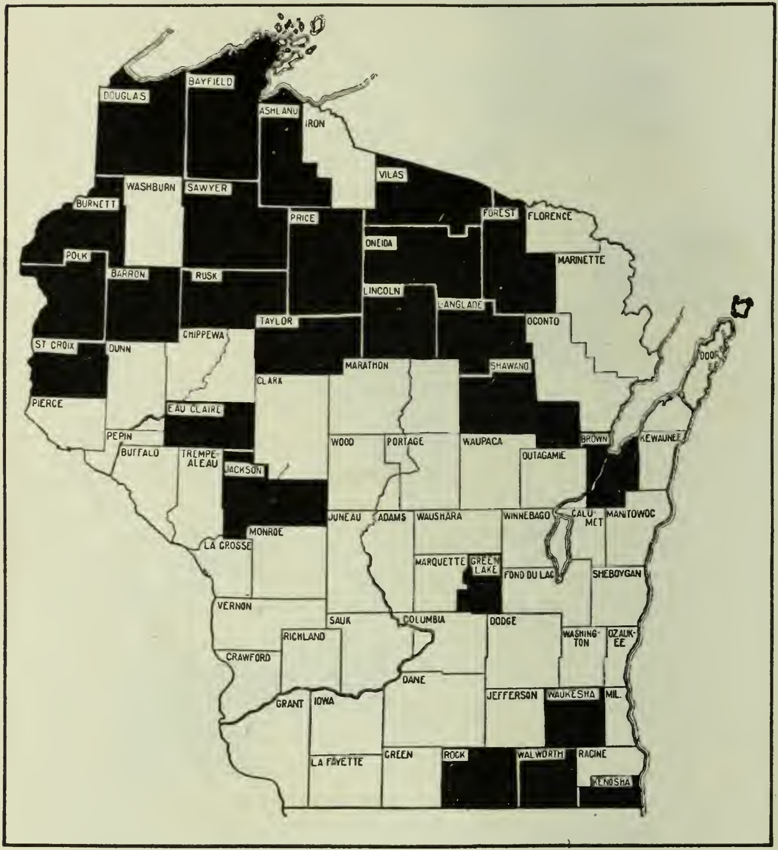


FIG. 14.—WHERE THE COUNTY AGENTS SERVED IN 1917

The war found a third of the state organized for systematic crop production.

Owing to the need for men in military affairs many of these county men entered the army. This, together with the ever changing food situation and the necessity for keeping all parts of the organization fully acquainted with the changing needs, made our administrative problems varied, numerous and difficult. Frequent conferences of state, district or local character were necessary—and the need for properly qualified men to fill vacancies in the organization became acute. Despite these handicaps very creditable progress was made, as is shown by the final results.

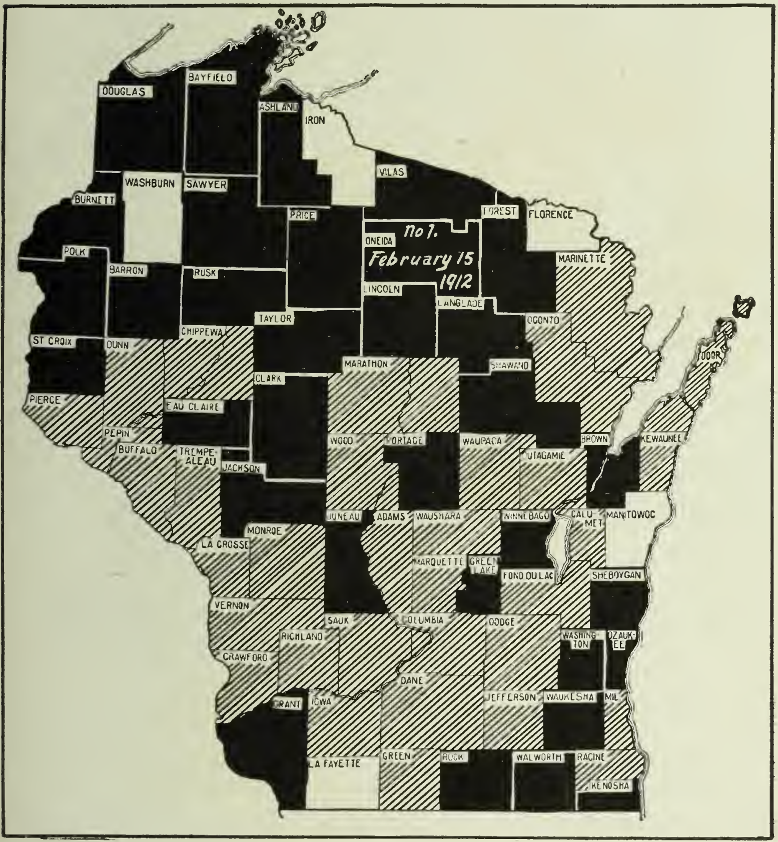


FIG. 15.—ORGANIZED TO SERVE IN 1918

Into all parts of the state, county agents or emergency food agents carried the slogan, "More Food This Year Is Patriotism."

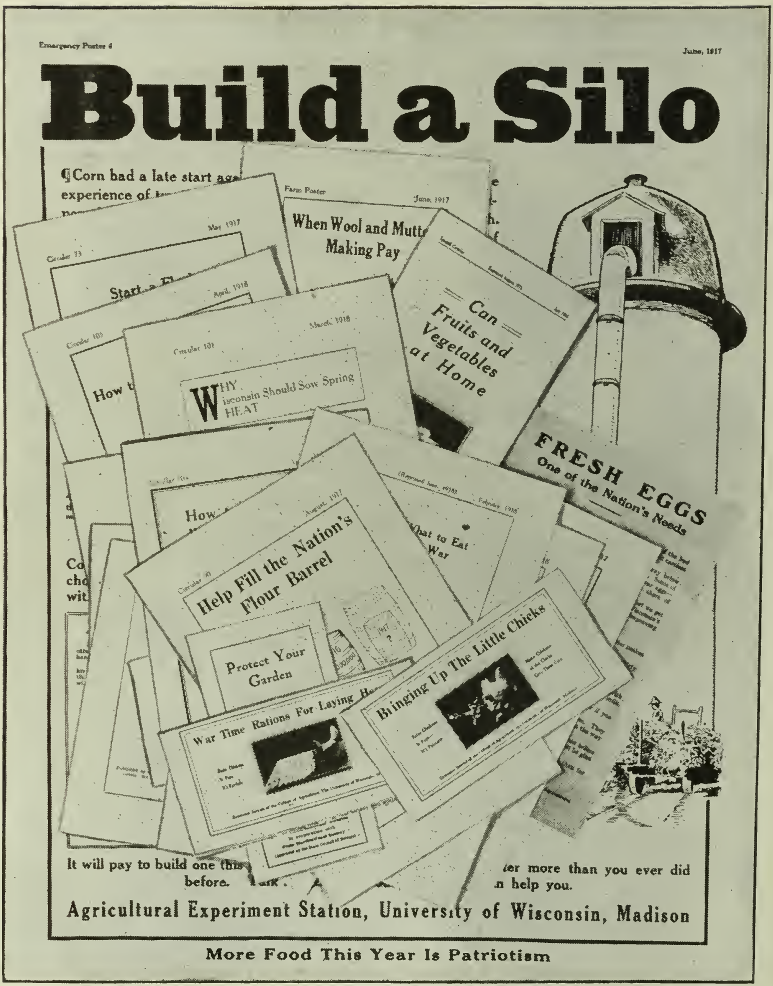

Emergency Poster 6
June, 1917
Build a Silo
Farm Poster
June, 1917
When Wool and Mutton Making Pay
Can Fruits and Vegetables at Home
WHY Wisconsin Should Sow Spring WHEAT
Circular 101
March 1918
FRESH EGGS
One of the Nation's Needs
What to Eat War
Help Fill the Nation's Flour Barrel
Protect Your Garden
War Time Rations For Laying Hens
Bringing Up The Little Chicks
It will pay to build one this
Agricultural Experiment Station, University of Wisconsin, Madison
More Food This Year Is Patriotism

FIG. 16.—SERVICE FROM PUBLICITY

Accurate information was ready at all times to help the farmer meet his war time obligations.

Publicity Pushes Production

Proper publicity is the pivot upon which turns the success of any campaign. The editorial department of the college did yeoman service in the preparation and distribution of bulletins, circulars, posters and press material aggregating nearly 2,500,000 copies:

28	extension circulars	958,750 copies
13	station bulletins	266,350 copies
4	poster bulletins	40,000 copies
20	special publications	1,255,600 copies
	Grand total	2,480,700 copies

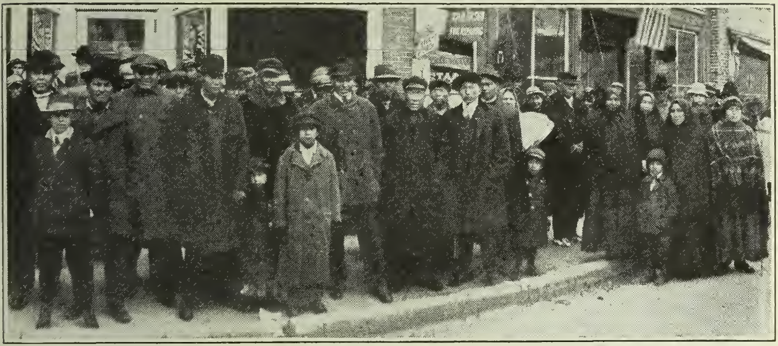


FIG. 17.—NO HYPHENATED AMERICANISM HERE

A group of Indian farmers leaving the hall at Black River Falls after participating in discussions on "Better Farming."

MEETINGS—THE EDUCATIONAL MEDIUM

As usual, the initial impulse was given to all campaigns of production and conservation through meetings of men and women. The college forces held 298 meetings which were attended by 80,000 people in addition to the numerous special meetings held by county and home demonstration agents and boys' and girls' club workers. Neither does it include innumerable meetings held under the auspices of the state and county councils of defense, each of which contributed to the main object of "helping to win the war."

BOYS AND GIRLS DO THEIR BIT

Nearly 40,000 boys and girls did their part by producing and saving nearly $750,000 worth of food products. The var-

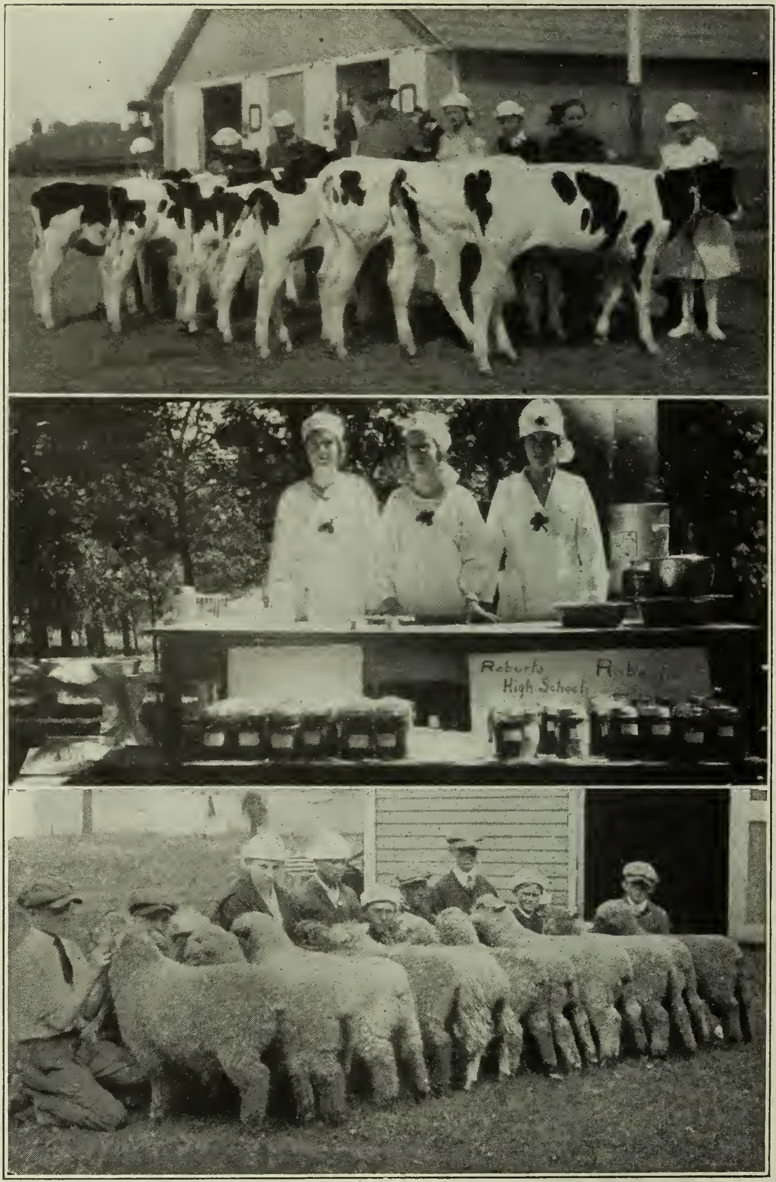


FIG. 18.—BOYS AND GIRLS DID THEIR BIT

More than 40,000 young folks enjoyed their clubs. They saved or produced nearly $1,000,000 worth of food products.

ious lines of club work undertaken by these young people is sufficiently suggested by the names given to the clubs: Canning, sewing, bread, corn, potato, garden, poultry, pig, calf, sheep, sugar beet and baby beef clubs.

INCOME AND FARM ACCOUNTS

A growing interest in the keeping of an accurate set of farm accounts as a basis for the statement of income required by state and federal authorities is apparent among farmers. Moreover, the farmer must be led to adopt business methods, just the same as in any other business. An account of stock must be taken annually which with income and outgo makes it possible to determine readily whether the farm is a paying or a losing venture. During the year just closed such books were kept on 677 Wisconsin farms through the instrumentality of farm management clubs, organized by the agricultural economics department. That this work is of prime importance at the present time is evident from the necessity for accurate records which must form the basis for any just form of income taxation imposed by both state and federal government.

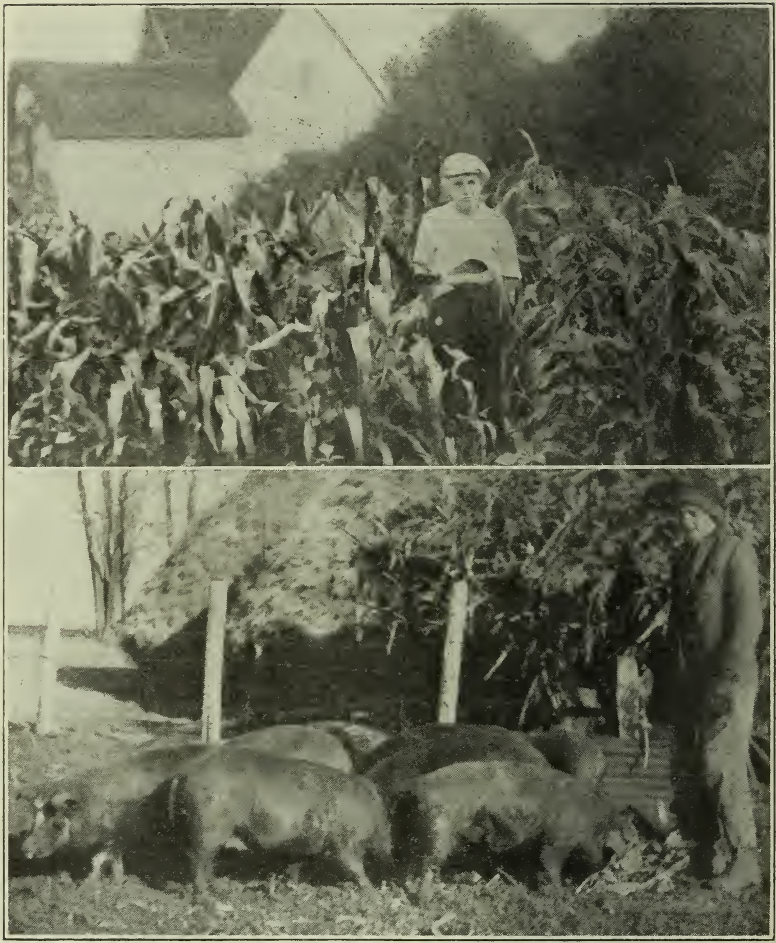


FIG. 20.—CORN AND PIGS GO TOGETHER

Out of the corn clubs established in 1906 has grown a $100,000 club activity. Two thousand boys took part in this work in 1918.

Published and distributed under Act of Congress, May 8, 1914, by the Agricultural Extension Service, College of Agriculture of the University of Wisconsin, K. L. Hatch, Assistant Director, the United States Department of Agriculture cooperating.

)75b

Bulletin 302 August, 1919

Service to Wisconsin

Annual Report of the Director of the Experiment Station for 1916-17 and 1917-18

H. L. RUSSELL and F. B. MORRISON

NEW SOILS BUILDING MAKES LARGER SERVICE POSSIBLE

Room for the expansion of the Soils Department, the State Soils Laboratory, and the State Soil Survey has been made possible since the completion of larger quarters.

AGRICULTURAL EXPERIMENT STATION
OF THE UNIVERSITY OF WISCONSIN

MADISON

CONTENTS

Introduction 3
Experimental work, by departments 5–63
  Agricultural bacteriology 45–46
  Agricultural chemistry 34, 49, 52–60
  Agricultural economics 36–38
  Agricultural engineering 35
  Agronomy 24–33
  Animal husbandry 54, 60–63
  Dairy 48–49
  Economic entomology 17–20
  Genetics 34–35
  Horticulture 5–7, 14, 20–23
  Plant pathology 9–13, 15–16
  Soils 38–45
  Veterinary science 50–51

Publications 64–
  Digest of station publications ....
  Technical articles ....

Financial statement ....

Service to Wisconsin

Diseases levy a heavy tax. Taxes are never popular. They are rarely paid gladly, even though we may realize that we get good returns in protection to life and property and in convenience and security of living.

Against taxes that are unnecessarily laid on us, however, we have the right to rebel. Yet year after year we continue to pay the penalty for indifference, apathy, stupidity, and negligence. Diseases, both plant and animal, continue to levy an annual toll not only on us, but on our possessions. We know that much of this loss is preventable, yet the toll of many millions of dollars a year continues to be exacted and we go on suffering the penalty.

Is it worth while to develop better blood and pedigreed seed, to work our improved cultural practices, and then let disease constantly drain our resources?

The war has been won but not yet paid for. Much can be done toward canceling the debt if the preventable losses that continually reduce our resources are checked. Science has not by any means answered all the problems that have been put up to her, and yet the solution science offers to a great many questions is not being widely utilized at present.

The discovery of the necessary methods of control such as are involved in the development of resistant strains of cabbage and localized soil disinfection with onions, resembles the struggle recently concluded in the great war, where a new type of gas attack had to be met by developing a new method of controlling it. On these Wisconsin fields it is continually a process of discovering and applying on a wide scale the methods of control that are necessary to hold these parasitic enemies in check.

While the scope of the work of the Experiment Station covers all fields of agricultural science and will be reported on later, some very important findings have been made by this station the last two years in the field of plant diseases and their control.

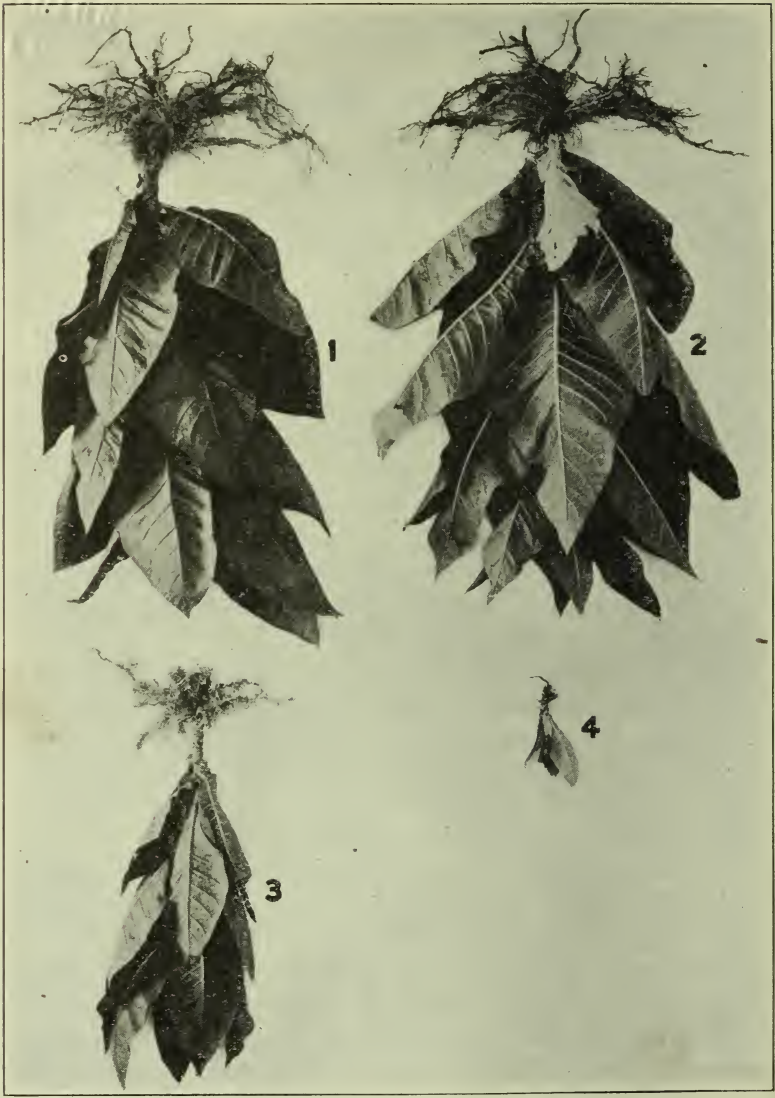


FIG. 1.—DISEASE RESISTANT AND SUSCEPTIBLE TOBACCO GROWN ON TOBACCO-SICK SOIL

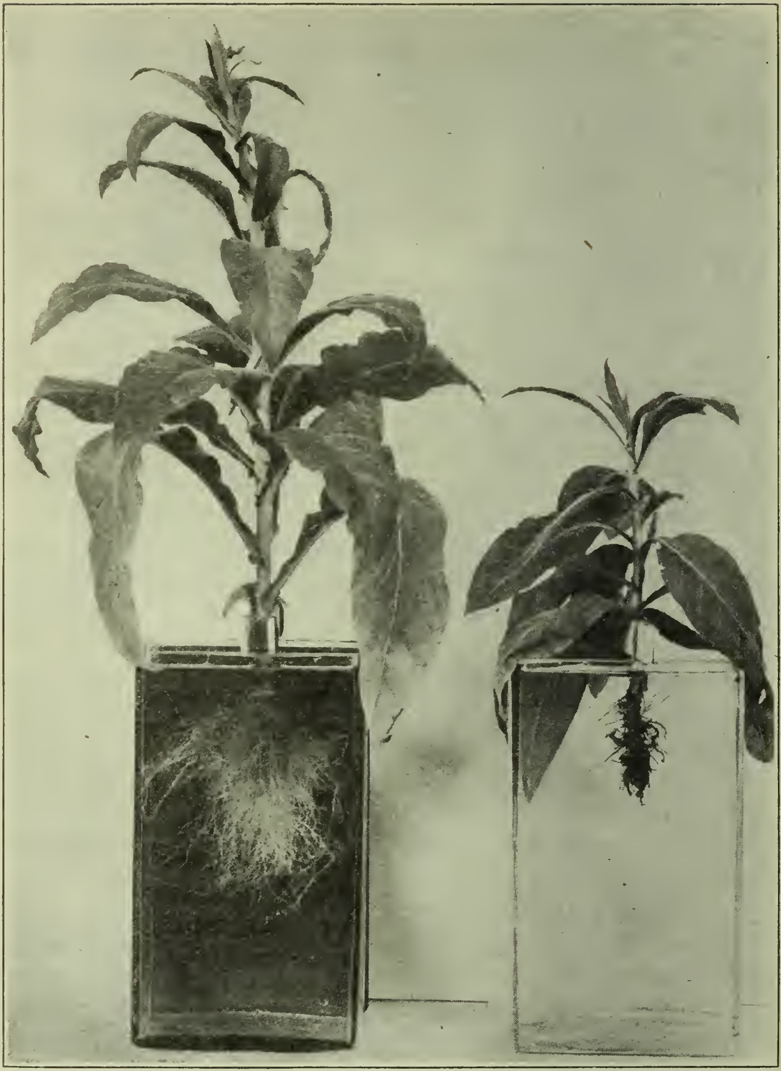
Varieties of tobacco which resist the root-rot disease are being developed: 1, a resistant Wisconsin type; 2, a resistant Burley (Kentucky) type; 3, an ordinary Wisconsin type; and 4, an ordinary Burley type.

THE RELATION OF SOIL TEMPERATURES TO PLANT ROOT DISEASES

Climate influences in a marked degree the occurrence or severity of plant diseases, as is strikingly illustrated with potato and cabbage diseases in Wisconsin. Most plant diseases are due to parasitic fungi or bacteria. Unless the germs of these are present the disease cannot occur, but, on the other hand, the parasite often develops serious disease only when climatic conditions are favorable.

Moisture and temperature exert the most marked effect. For instance, in 1915 during a season which was peculiarly cool and moist, the fungus (*Phytophthora infestans*) causing the late blight of potatoes destroyed some millions of dollars' worth of Wisconsin potatoes, producing the worst outbreak for at least a decade. As a result, the seed used the next year generally carried the infection to all fields; yet, by reason of the dry hot weather of that season, the parasite was so completely held in check that even the potato specialist had to search the fields diligently with a magnifying glass to find a trace of the trouble.

By way of contrast, in 1915, alongside these sick potato fields in Wisconsin, the cabbage crop was everywhere vigorous, even on the worst ''cabbage sick'' soils. The fungus causing cabbage sickness, the Fusarium organism, thrives poorly under cool and moist conditions but luxuriantly in hot weather. Under the dry heat of 1916 it was observed that these same cabbage fields were swept by the ''yellows'' disease as if by fire. In view of such experiences, it has seemed highly important to investigate further the influences of temperature, and especially soil temperature, as a limiting factor in the occurrence of other plant diseases. With cabbage yellows the parasite is stimulated by soil temperatures above 62.5°F. Root rot of tobacco, caused by another soil-inhabiting fungus (*Thielavia basicola*), according to J. Johnson (horticulture) responds in a quite different way to variations in soil temperature. The low temperatures which serve to check the development of the cabbage parasite permit an aggressive development of the tobacco organism. Contrariwise, a rise in soil temperature stimulates the cabbage parasite, but checks the tobacco parasite. Fortunately, the tobacco plant thrives at the higher soil temperature. The outcome is that with infested soil the tobacco root-rot will, during



A B

FIG. 2.—HEAT CHECKS ROOT-ROT DISEASE

Both of these tobacco plants were grown on "tobacco sick" soil and became badly diseased. "A" was then transferred to a high soil temperature (86° F.) and "B" to a medium soil temperature (68° F.). The new roots growing from the diseased stump of "A" did not become infected whereas those of "B" rotted as rapidly as produced, thus checking development of the plant.

the cool spring period, develop severely in the seed bed, which fact emphasizes the importance of steaming the soil in such seed beds to sterilize them. Transplanted, the disease is worse during the early part of the summer, when the soil is cooler, and may thus hold the development of the plant almost entirely in check. If, however, the soil warms up sufficiently, in late July or August, the parasite is checked, while at the same time this higher temperature stimulates the normal growth of the tobacco with the net result that in early August a field which had before appeared almost hopelessly diseased will suddenly forge ahead and make a moderate crop.

This relatively new suggestion in the field of plant pathology seems likely to afford a more satisfactory explanation for the rise and decline of certain plant diseases than has heretofore been presented. The additional facilities of a controlled temperature regulation which the experiment station has installed this year will enable these studies to be prosecuted vigorously.

DISEASE RESISTANT STRAINS OF TOBACCO DEVELOPED

Reference has already been made to the relation worked out by Mr. Johnson between temperature and the development of the root-rot disease of tobacco. Working in a cooperative relationship with the U. S. Department of Agriculture (tobacco investigations) he has enlarged the scope of his work materially so as to cover the entire tobacco-growing area of the United States.

Already especially promising individual plants have been obtained in the selection of disease-resistant strains. While success has been secured in growing these strains, the curing qualities have not yet been tested finally, but all indications point toward the commercial success of this work. Especially interesting results which may have much practical importance have been secured by crossing the resistant Little Dutch variety upon the very susceptible White Burley type, with the idea of combining the resistant characteristic of the Little Dutch with the "white" characteristic of the Burley strain. The first generation of these crosses yields all green plants, which were found intermediate in resistance. The second generation shows a range in variation as regards resistance equal to that which obtained between the two parents. Some of the second generation were also found to be "white." Results of these cross-breeding trials indicate that resistance appears to follow the Mendelian laws of inheritance with respect to leaf and color of the "white"; that is, reduced chlorophyll character is found to be recessive. So far, a resistant white Burley type has been secured by these means although as yet nothing is known of its commercial value. The method, however, suggests an important way of developing resistant strains.

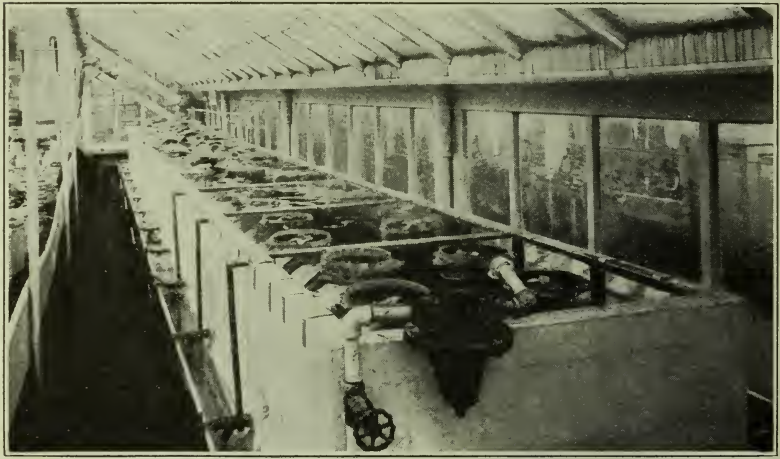


FIG. 3.—TANKS IN WHICH THE TEMPERATURE CAN BE CONTROLLED

Cold water is circulated around the pots at low temperature while the higher temperatures are obtained by heating the water by steam or electrical units. The different plants are grown in these temperature-controlled pots.

Other studies of the influence of environmental conditions on the development of root-rot disease, have been made on the influence of soil moisture, physical texture of the soil, amount of vegetable matter in the soil, the relation of fertility, the amount of infection in the soil, and the influence of relative acidity. The soil fungus unquestionably develops best at relatively low temperatures and appears to be almost entirely checked under higher temperature conditions. Moisture does not seem to play any important part in producing infection unless the saturation point is practically reached. The other environmental factors do not appear to be more than of minor value.

In rotation experiments the tobacco root-rot fungus has been found to attack practically all leguminous plants, but it infects some very much more than others. Cowpeas and soybeans are seriously attacked and undoubtedly it would be unwise to use them in rotation with tobacco on soil infested with root-rot, although experimental evidence has not yet been secured on this point. Clover and alfalfa do not appear to be seriously attacked, but they do, no doubt, aid in maintaining the parasite in the soil.

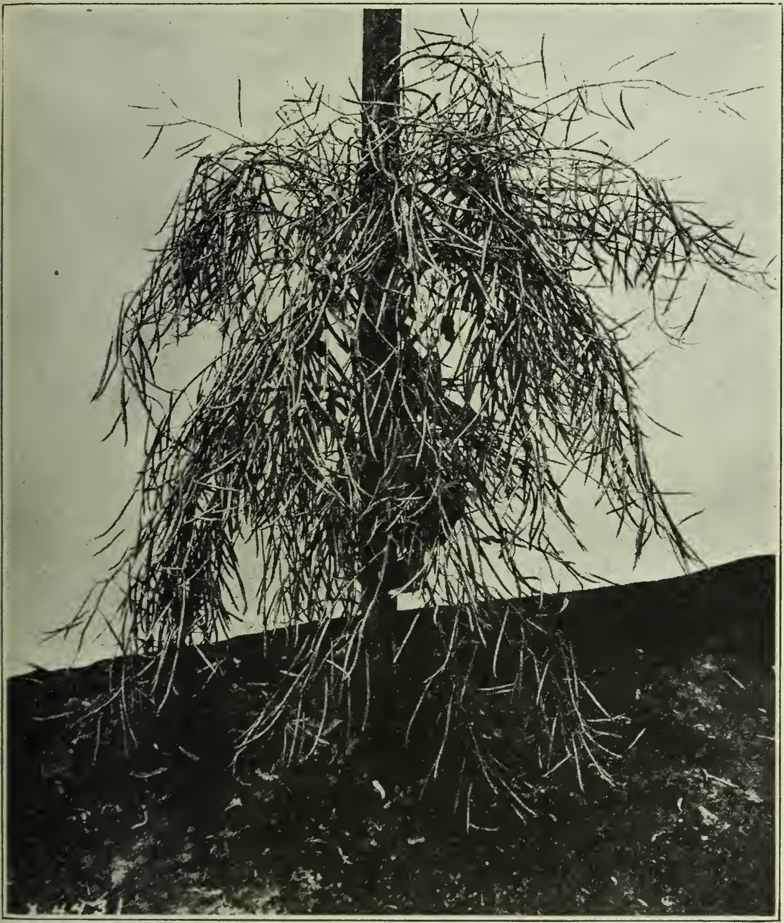


FIG. 4.—A RESISTANT CABBAGE PLANT READY FOR SEED HARVEST

The heavy branches are supported by tying to stakes. Nearly 1,000 pounds of "resistant" seed were available for planting in 1919.

CABBAGE YELLOWS CONTROLLED THROUGH DISEASE RESISTANCE

Kraut varieties. The success which has attended the efforts of the Plant Pathology Department in developing a commercial strain of winter cabbage which is able to withstand the inroads of "cabbage yellows" has led to similar efforts with the kraut varieties of cabbage. With the Brunswick and All Seasons varieties efforts have been successful. One of these new strains of All Seasons tested in 1917 and again in 1918 possesses a very high degree of resistance, practically equal to that of the Hollander variety. It is uniform in type, and of excellent kraut quality. A committee of the National Kraut Packers' Association, one of whose members is a Wisconsin packer, has assumed the responsibility for increasing the amount of this new resistant strain on a commercial scale.

Winter varieties. The Hollander or winter strain that L. R. Jones (plant pathology) in earlier years has so successfully developed to resist the Fusarium yellows has been further improved, making it more uniform of type and earlier in ripening. While these desirable qualities were being developed it has been tested on sick soil to preserve its resistance to disease.

Seed of this type has been multiplied through the efforts of the Racine growers' committee, so that approximately 1000 pounds was available for 1919 planting.

SEED AS A SOURCE OF CABBAGE BLACK LEG DISEASE INFECTION

J. C. Walker(plant pathology) made in 1917 a series of observations indicating very clearly that cabbage seed not disinfected can transmit the black leg disease (*Phoma lingam*) infection from one year to the next. For example, in two fields planted to resistant Hollander strains undisinfected and disinfected seed (treatment 1 part formaldehyde to 240 parts water, 20 minutes exposure) was used. Two weeks after transplanting the black leg was noted in the field planted with the untreated seed and during the course of the summer developed to the point of destroying over one-half of the crop, while that planted with the treated seed remained free.

The field data of 1918 indicate that the recommended formaldehyde seed treatment is not sure to kill all the fungus which has penetrated the seed coats. Experiments are now under way in the laboratory testing the comparative value of seed treatment with formaldehyde, corrosive sublimate, and dry heat.

When obtaining disease-free mother seed for increase, the careful selection of healthy mother seed plants and disease-free seed pods is highly important.

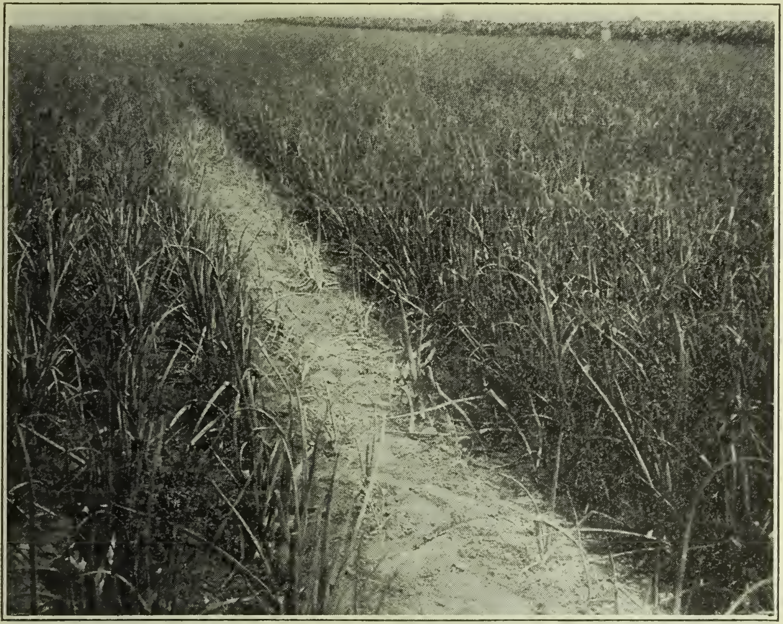


FIG. 5.—FORMALDEHYDE CONTROLS ONION SMUT

The two rows in the center are untreated. The rest of the field was treated with formaldehyde by means of a drip attachment on the seeder.

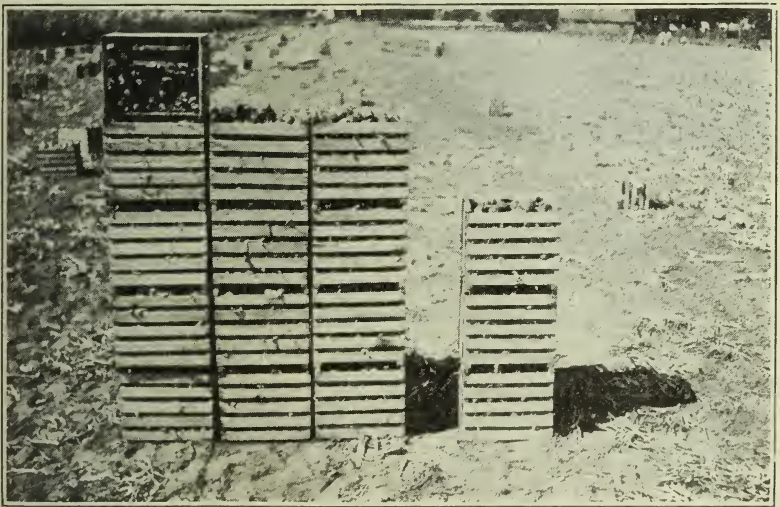


FIG. 6.—FORMALDEHYDE MULTIPLIES CROP BY FOUR

Three crates of onions from two untreated rows; nearly 13 crates from the rows where formalin at the rate of 1 ounce to a gallon of water was applied to 185 feet of drilled row.

$59 OUTLAY YIELDS OVER $3000 PROFIT

This sounds like an Aladdin story. Yet N. Grabher of Racine, the owner of two onion fields aggregating 11.8 acres, says that the application of formaldehyde with his onion seeding netted an increased yield of 3380 bushels at a cash outlay of $59. R. E. Vaughan (plant pathology) used on this farm the method previously described (Bulletin 250, Director's Report 1914) of local disinfection with formaldehyde of the soil in the immediate vicinity of the onion seed. The onion plant is highly susceptible to the smut organism just as the seed germinates. After the root system is established resistance is increased. Therefore, if the soil can be locally disinfected in the vicinity of the seed, the disease can be readily controlled.

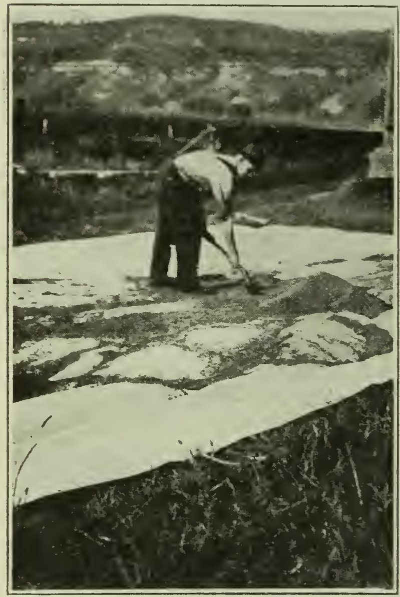


FIG. 7.—TREATING RYE TO REMOVE ERGOT

After running the rye through a brine tank, the seed can be readily dried on canvas or a barn floor.

BRINE BATH REMOVES RYE ERGOT

The disease of rye called ergot has been known a long time. It causes a reduced yield by replacing the kernels and blasting the flowers. It is furthermore highly objectionable because of some poisons mixed with the grain. It has been claimed that abortion is caused by the use of rye infected with this organism. The disease is transmitted to the new crop by ergot mixed with the seed. Since these black ergot bodies do not infect the sound kernels themselves, the seed may be used with safety if the ergot is removed.

When rye and ergot are stirred into a 20 per cent salt brine bath (40 pounds salt to 25 gallons water) the good kernels sink and the ergot with light kernels and some weak seeds rise to the top, where they can be readily skimmed off. A. G. Johnson (plant pathology) has found that if the brine is drawn off promptly its action for such a short time has no effect upon germination, providing the excess salt is removed by rinsing the cleaned seed in two or three changes of fresh water. The removal of the salt sticking to the seed is necessary to rapid drying.

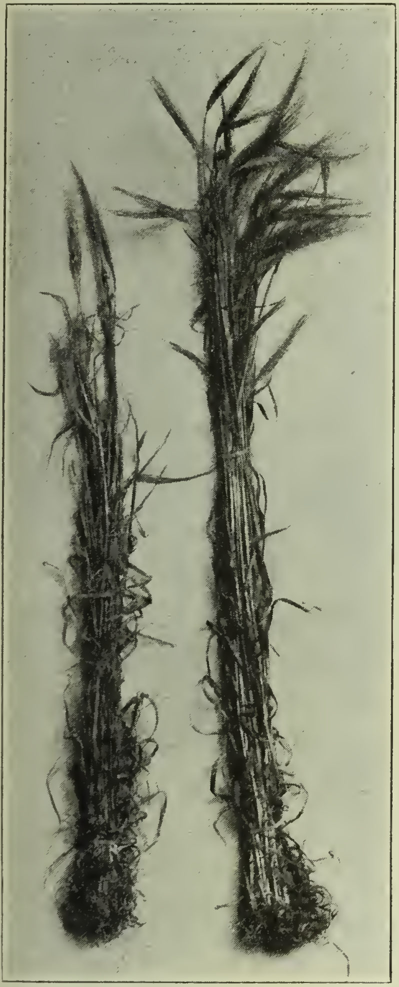


FIG. 8.—BARLEY STRIPE TAKES HALF THIS CROP

One hundred plants were pulled as they came in the row; the 50 "striped" or diseased plants at the left, the 50 healthy plants at the right.

STRIPE DISEASE OF BARLEY INCREASES IN WISCONSIN

For several seasons there has been a marked development of barley stripe disease in the state. This is particularly noteworthy in the southeastern and lake shore counties where it has been noted in previous years in small amounts. The unusually cool spring favored the development of the disease and A. G. Johnson (plant pathology), working with emergency food agents, county representatives, and field scouts of the United States Department of Agriculture, found a widespread infection of barley fields. In some fields only a trace of stripe was found, while as much as 40 to 50 per cent was discovered in others. In all, 540 fields were examined and 5.2 per cent of all of the plants, were found to have the stripe.

Since this disease develops more extensively in cool soils, it might be thought that it could be avoided if barley were planted later, but when this is done the crop not only matures later but is usually attacked by the stem rust so that it seems more desirable to combat the stripe disease by seed treatment and early sowing.

Recommendations for treatment now offered are: After thoroughly cleaning the seed, soak for two hours in a formaldehyde solution (1 pint of formaldehyde to 30 gallons of water), drain, and spread out to dry. Plant as soon as dry enough, or dry thoroughly if seed is to be stored. This treatment will control covered smut perfectly and will greatly reduce stripe and loose smut with certain varieties, particularly Wisconsin Pedigree No. 9.

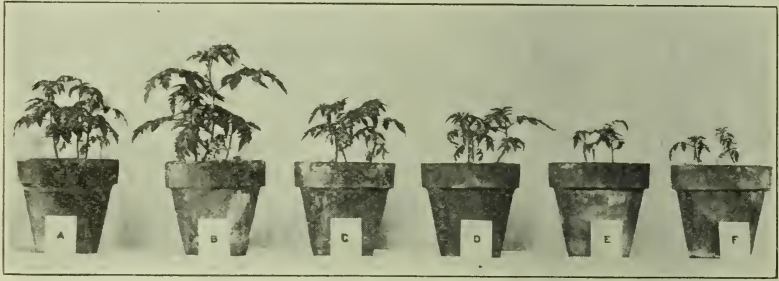


FIG. 9.—CERTAIN SOILS MAY BE OVERSTERILIZED FOR BEST PLANT GROWTH

Pot A was a virgin sandy loam unsterilized; B, C, D, E, and F, were heated to 240° F. for 10, 20, 40, 80, and 160 minutes respectively. Plant growth decreased with the length of heating.

HEATING SOILS AFFECTS PLANT GROWTH

Soil sterilization is now widely practiced by the tobacco growers of the state. J. Johnson (horticulture) has conducted extensive experiments for the purpose of determining more definitely the reason for the increased growth of plants, and their temporary retardation on heated soils. For this purpose a wide variety of soils, plants, temperatures, and conditions have been used. The results are of special value from the standpoint of plant disease studies conducted on heated soils.

When soil is sterilized by heat, plant food is not only rendered more available but gradually becomes more available due to increased activity of soil microorganisms. Compounds injurious to plant growth are, however, produced at the same time and these are believed to be largely ammonium compounds. On the other hand, these injurious compounds are gradually lost, and their disappearance is found to be due to the activity of microorganisms. The temperature of the soil and other environmental factors are largely influential in determining the rate at which this injurious property disappears. Types of injury have been found, other than checking seed germination and plant growth, which closely resemble injury from plant parasites. The injurious action is much more marked in some soils than in others, and some plants are more susceptible to it than others. The temperatures to which the soil is heated, and in some cases the length of time the soil is heated, determines the extent of the injurious action. Fig. 9 shows tomatoes grown in a virgin sandy loam heated to 240° F. for various lengths of time.

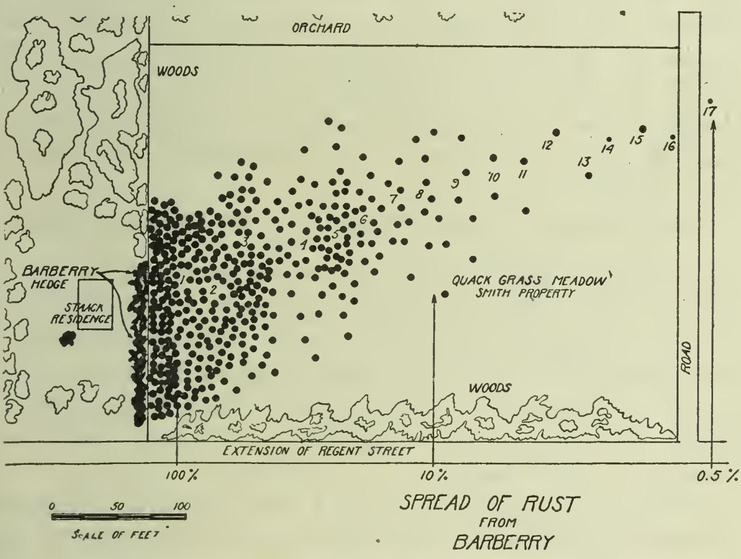


FIG. 10.—HOW BARBERRY BUSHES SPREAD RUST

A barberry hedge was infected with rust; at 200 feet there was a 10 per cent infection of a quack grass meadow.

BARBERRY SPREADS GRAIN STEM RUST

During the spring and summer of 1918 an intensive study of the grain stem rust problem in Wisconsin was undertaken by A. G. Johnson and J. G. Dickson (plant pathology), the chief object being to accumulate more definite and detailed data upon the role of the common barberry (*Berberis vulgaris*) in the spread of the stem rust of grains (*Puccinia graminis*). This work was in cooperation with the U. S. Department of Agriculture and was correlated with the barberry eradication campaign of the State Department of Agriculture, and similar campaigns carried out in neighboring states of the northern Mississippi valley. The spread of the rust from the old rusted straw to the barberry and subsequent spread from the barberry to the new grain crops and grasses was definitely observed at about 50 selected stations. In each case the original infection was traceable directly to infection on barberries. In no case was early rust infection on grains or grasses noted apart from infections on the barberry.

The observations on the distribution of stem rust are in line with the fact that there are three specialized strains on the grains. The wheat strain grows only upon varieties of wheat and barley, the rye strain only upon varieties of rye and barley, and the oat strain only on varieties of oats. These three strains also go to several wild grasses and all go to the barberry, but from the barberry will rust only their special host again.

PLANT DISEASE SURVEY SHOWS NEED OF DISEASE CONTROL

An extensive plant disease survey was carried out in 1918 by membes of the Plant Pathology Department in ooperation with the various county agents, emergency food agents, and field scouts from the United States Department of Agriculture, Office of Cereal Disease Investigations and Plant Disease Survey. Nearly 3600 observations were made, very largely on different cereal and potato diseases.

The survey brought out the fact that frequently farmers do not realize the extent to which their crops are damaged by these insidious fungus enemies; for example, a 10 to 15 per cent infection with barley stripe often went unnoticed and unchecked.

The return of Wisconsin to a prominent place among the wheat-growing states brings out the importance of checking the start of stinking smut (bunt) and other enemies of this crop. In one field as high as 60 per cent of the heads were destroyed by this fungus, and in many fields 2 to 4 per cent of infection was seen. The disease can be controlled by the use of formaldehyde solution.

The plant disease survey has given us information upon the diseases and the localities where the message of plant disease control may be carried with profit in succeeding years.

W. H. Wright and J. W. Brann of our staff were engaged in a cooperative survey with the federal department during the summer of 1918. As a result of their work an early outbreak of potato late blight was detected in Barron county on August 13. A spraying campaign was at once started by the county agent, R. L. Cuff, which aided greatly in checking the disease.

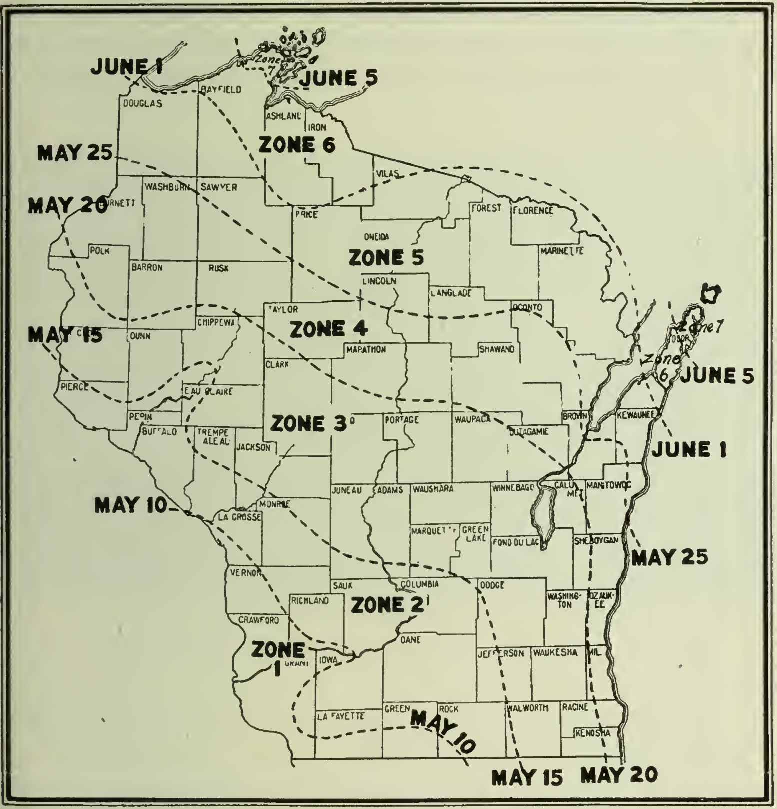


FIG. 11.—WHEN THE WEALTHY APPLES ARE IN FULL BLOOM

The zones into which the state is divided for spraying are based on approximate dates. Half the apple crop is lost because of codling moth and the plum curculio.

LATE SPRAYING OF APPLES PREVENTS WORM INJURY

The codling moth and the plum curculio take half the value of the apple crop. Experimental work carried on in the insectary and in orchards by C. L. Fluke and L. G. Gentner (economic entomology) at five different points in the state has shown that the present spray schedules were not properly timed to exert the greatest effect on the destruction of larvae. In general, it has been the custom to apply the last spray from July 25 to August 1, but breeding experiments and field observations for the last three years show that an additional treatment should have been made before the middle of September, or that the application should have been delayed until August 10 or 15.

From breeding cage experiments, Mr. Fluke finds that the maximum number of eggs of the second generation are not deposited until the first week in September (1917) or the last week in August (1918).

Due to the variation in time of blossoming, it is impossible to give any specified dates for spraying; if the trees are late in developing the moth is also likely to be delayed. The first two sprays are to be applied on the basis of bud development, and from this it is easy to compute time of the other applications. The general order of procedure recommended is:

1. ''Pink'' spray, applied when the buds are breaking in the cluster and show pink; to be applied at Madison (Zone 2) for a normal season about May 15. For other zones this date would vary (See fig. 11). Use arsenate of lead powder, 2 pounds to 50 gallons of water, adding 5 quarts of lime sulfur for control of scab.
2. Calyx spray, applied when petals have fallen and before calyx cup closes. Same spray as in (1), except that only one pound of arsenate of lead instead of two is used.
3. Second moth spray, about two weeks later, using same spray as in (2).
4. Summer spray about 55 days after second moth spray, using lead arsenate powder 1 to 50.

CODLING MOTH SPRAYS CONTROL THE PLUM CURCULIO

Experimental work in breeding cages and observations in the field by the Economic Entomology Department have shown that the plum curculio does its maximum amount of damage to apples during the first two or three weeks after the blossoms fall. If the codling moth is not present, two sprays of lead arsenate 1 to 50 (a calyx spray and a second one a week later) will suffice to control the curculio. The demonstration spraying for the codling moth indicates that the schedule for controlling this pest is, under normal conditions, satisfactory in controlling the curculio.

WORMS RAVAGE THE CABBAGE CROP

For the last three years the imported cabbage worm has been an abundant and destructive pest not only in gardens but in commercial fields. In numerous cases fully one-third to one-half of the crop has been destroyed. Treating the crop is not a difficult problem but the grower often fails to spray because of the supposition that sprayed cabbage is dangerous to the consumer.

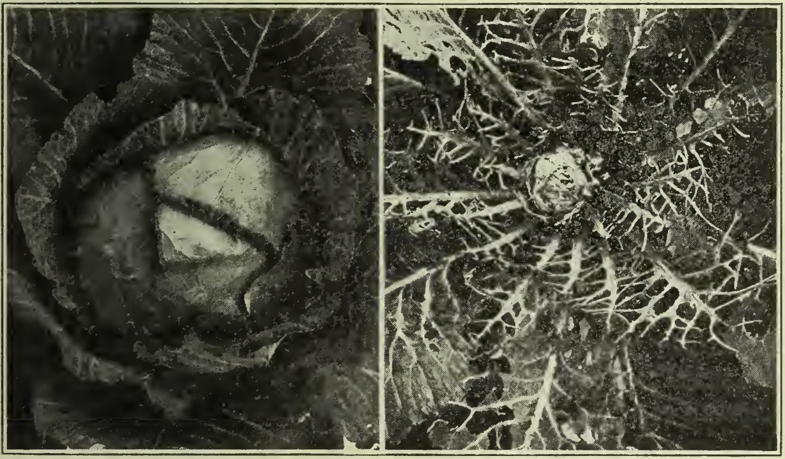


FIG. 12.—CABBAGE WORMS DESTROY VALUABLE FOOD CROP

The untreated head (right) was lost; the other head was sprayed twice with arsenate of lead, 1 pound to 50 gallons.

Arsenates of lead and lime, also arsenite of zinc, used both in wet and dry form, were employed by L. G. Gentner (economic entomology). Wet sprays were found to be more effective, and ordinary resin laundry soap (1 pound to 50 gallons) proved satisfactory in making the spray stick to the waxy surface of the cabbage leaf. Either arsenate of lead or calcium arsenate (50 gallons water, 1 pound powdered arsenate, 1 pound resin soap, dissolved) applied three times (July 15, August 15 and September 10) was found to be effective. In the dust spray 1 pound of poison is used with 10 pounds of air-slaked lime when the dew is on the leaf.

A chemical examination made of sprayed and unsprayed heads showed that there is no danger of arsenical poisoning from this treatment when the outer leaves of the plant are removed.

MAKE TESTS OF INSECTICIDES

The high cost of chemicals due to war conditions has made necessary a careful study of the comparative worth of various insecticides that can be used more or less interchangeably. The Economic Entomology Department has investigated the four leading insecticides, paris green, arsenite of zinc, arsenate of lead, and arsenate of lime. In these tests the grubs of the potato beetles were used to compare the killing power of the various poisons.

Hydrogen arsenate of lead was found to give nearly as good results as paris green, both destroying the grubs within three hours. Commercial arsenate of lead gave slightly poorer results, as did arsenite of zinc. Arsenite of zinc did not cause any apparent injury to potato vines, but did produce some burning of apple foliage. Arsenate of lead had no bad effect on the foliage of either the potato or the apple. These insecticides may be used as substitutes for paris green, if varying conditions are taken into consideration. The high cost of paris green at the present time makes the consideration of this matter of economic importance.

FERTILIZERS AFFECT CHERRY PRODUCTION

The cherry interests in Door County some years ago asked for the inauguration of experimental work to determine the limiting plant food factors in cherry production. Tests were begun by the Horticultural Department in 1914 on an 8-year old Early Richmond orchard, planted 20 by 20 feet on silt loam of limestone origin, typical of most of the cherry soils in that district. Fertilizers were applied annually, nitrogen being added in the form of three pounds of dried blood and one pound of sodium nitrate to each tree; phosphorus, seven pounds of acid phosphate to each tree; and potassium, three pounds of sulfate of potash. Clean cultivation was practiced and for two seasons a cover crop of oats was sown. In the other years, weed growth was relied upon to furnish the necessary cover.

Yield records were taken in 1914, 1915, and 1917. In 1916 and 1918 severe winter injury practically destroyed the crop. The most definite results obtained by R. H. Roberts and G. F. Potter (horticulture) from this experiment indicate the value of the nitrogenous fetilizer used either alone or in combination with phosphoric acid and potash. Although no crop was harvested in 1916, the foliage and vigor of the trees showed the distinct advantage of the nitrogen plats. In 1917, the average yield from each tree on the check plat was 65.4 pounds of fruit, while those on the plat receiving nitrogen alone gave 82.5 pounds Plats receiving nitrogen showed an increase in yield, while trees to which only potash and phosphorus were added showed no gain over check plats.

The use of the nitrogenous fertilizer also seemed to produce a change in the fruiting habit of the tree. Trees receiving nitrogen carried a large proportion of their crop on two- and three-year old spurs. Trees receiving no nitrogen produced their fruit almost entirely from lateral buds on one-year old wood. For best fruiting with the cherry it is desirable to have as many spurs as possible developed. When the growth of the tree is such that new wood is short, all of the buds on the one-year old wood become fruit buds, and consequently, spurs cannot develop. On the other hand, if the tree is vigorous and the new growths exceed a foot in length, many of the lateral buds then develop into spurs. It is therefore evident that, for highest production, the cherry must be encouraged to produce rather long seasonal growths, which occur most markedly in the trees receiving nitrogen.

This increased growth, however, raises another problem—that of keeping the tree within bounds and low enough so as to make spraying and harvesting easier. It is thus evident at once that the question of maintaining maximum fruiting and spur production must be intimately associated with pruning.

WINTER INJURY TO CHERRY BLOSSOM BUDS

A difficulty confronting the Wisconsin orchardist is winter injury to fruit buds. This occurs frequently with the cherry, and at times may happen to the extent of materially reducing the crop. Such an injury occurred in the winter of 1915 and again in 1917. R. H. Roberts (horticulture) has noted that winter injury occurs most readily in buds which are most developed.

The primary source of the trouble seems to be located in the pith of developing fruit stems (pedicel) and in the epidermal blossom cells, especially in the sepals. The occurrence of injury is evidently related to the condition of the protoplasm of the succulent plant cells. Cells having large vacuoles seem to be more readily injured by unfavorable temperatures than those completely filled with cell substance (cytoplasm), a condition doubtless due to the dilution of the cell sap. This condition of the cell is closely related to the amount of growth made by the fruit spur or limb upon which it is borne. The greatest development occurs along the middle of the growths from two to four inches long. Less injury was noted to basal and end buds than those in the central portion of the shoot. Blossom buds on short spurs show much less injury than those on long terminal growths.

This fact has an important practical application. Generally no spurs are formed if the terminal growths are less than six inches long; and most of the buds on a twig develop into spurs if the growth is over 12 inches long. From this relation of growth to spur formation, and the greater cold resistance of blossom buds on spurs, the necessity of controlling the rate of growth of the tree largely through proper soil management becomes apparent. Pruning also plays an important part, as the length of life of the spurs is considerably influenced by the density of the top of the tree. When it is necessary to promote rather rapid twig growth, in order to encourage spur development, it is also necessary to practice a definite system of pruning to keep the top of the tree sufficiently open to insure long life and vigor of the spurs thus formed. Contrary to the usual recommendation concerning the pruning of the sour cherry, it has been found that much more satisfactory results can be secured where a definite system of rather heavy pruning is followed with trees which are making sufficient growth to provide for maximum production.

RELATION OF PRUNING CUTS TO WOUND HEALING

Horticulturists recognize that it is poor practice to leave any stubs in pruning and it is usually recommended that in the removal of branches the cut should be made, ''parallel to the supporting branch or trunk, and as close to it as practicable.'' This necessitates the removal with the branch of the so-called ''collar'' or enlargement at its base. The resulting wound is thus relatively large in relation to the diameter of the limb removed.

From a practical point of view, however, it has long been recognized that pruning can be done with much less labor if the cut is made at the outer edge of the collar, which is from a quarter-to-a-half-inch away from the main branch.

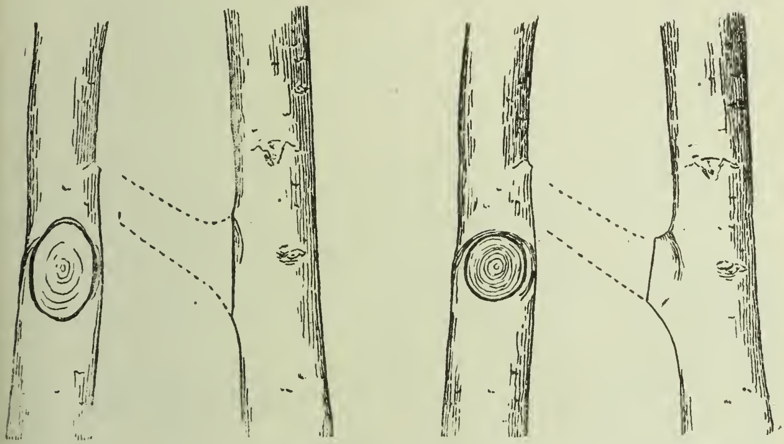


FIG. 13.—PRUNE OUTSIDE "COLLAR"

Making cuts at the outer edge of the collar (right) is preferred to making the cut close (left) to the main trunk or branch. The smaller exposed surface will heal quicker.

G. F. Potter and R. H. Roberts (horticulture) have carried out a series of tests to determine the relative rate of healing. As healing of the wound proceeds largely in a horizontal direction from the edge of the wound, the horizontal diameter is of importance. In the series of tests referred to it was noted on the average that the horizontal dimension was fully 15 per cent smaller when the cut was made at the outer edge of the collar, in comparison with close cuts immediately next to the tree trunk. The relative rate of healing did not appear to be materially different in the two types of cuts. As the only advantage which can be claimed in favor of making cuts close to the main trunk is in an increased rapidity of healing, it appears that the method of making the cuts at the outer edge of the collar is to be preferred, as the smaller exposed surface will heal sooner than when the cut is made closer to the supporting branch.

HEMP CULTURE SPREADS IN STATE

Just as the boll-weevil drove the cotton planters of the south out of cotton culture and into peanuts and livestock, so Canada thistles and quack grass have been the means of introducing a new crop into Wisconsin. No better smother crop can be grown than hemp, and it was in trying to kill these noxious weeds with hemp that the suitability of the crop to Wisconsin soil and climatic conditions was first determined.

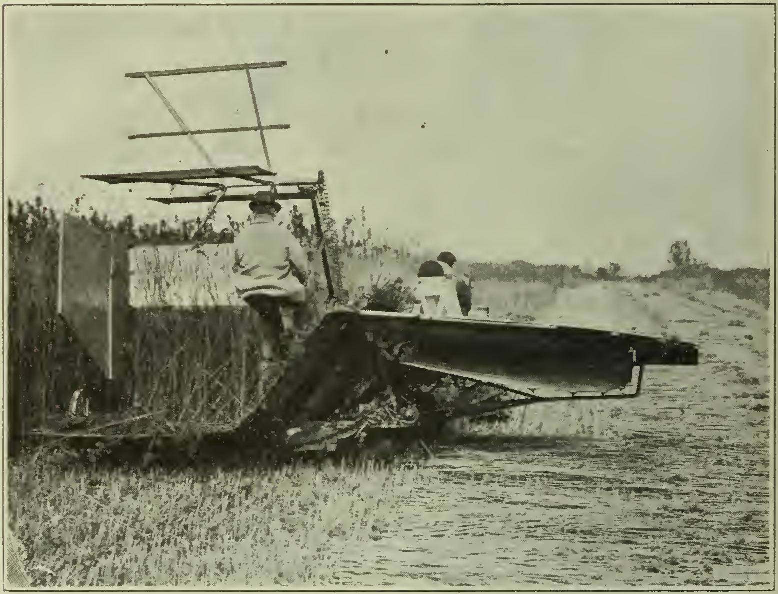


FIG. 14.—NEW HEMP HARVESTER MAKES HEMP GROWING EASIER

This machine cuts and spreads the hemp at one operation, saving a great deal of hand labor.

In cooperation with the Office of Fiber Investigations of the United States Department of Agriculture, the Agronomy Department has since 1908 carried out work on the adaptability of hemp as a crop in this state.

Because hemp growing cannot be very successfully carried out except where it is grown on a large enough scale to warrant the installation of hemp mills, it requires cooperation to develop centers in which the industry can flourish. Not less than 300 acres are needed to make a nucleus large enough to warrant the building of a mill. Already Wisconsin has more hemp mills than any other state. In this state the crop has been developed mainly in Fond du Lac, Dodge, Green, and Racine counties.

Hemp needs a well-drained, fertile soil—in fact, a good corn soil. By many it is thought to be hard on land, but when grown in rotation on well-manured ground and retted on the soil, it is not a hard crop.

An acre yields about three tons of dry stalks, from which there is extracted about 1000 pounds of fiber, yielding 700 pounds of long fiber (line) and 300 pounds of short fiber (tow). The hemp plant is particularly free from all insect injuries, and the crop is worth from $50 to $100 an acre. The fiber is used mainly in the manufacture of commercial twines and cordage and for calking ships. With the rapid rise in the price of sisal for binding twine it was used as a substitute for this necessary supply for the farmer during 1918.

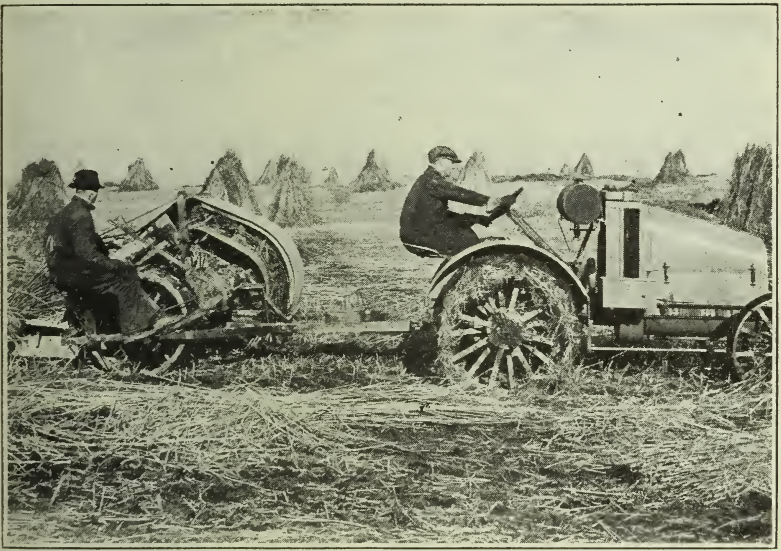


FIG. 15.—THE NEW HEMP GATHER-BINDER AT WORK

After retting, the hemp is lifted and bound in bundles in this newly devised labor-saving machine.

Kentucky has long enjoyed the distinction of growing the best hemp and producing more than all other states in the United States together, but in the last few years the industry in Wisconsin has grown from practically nothing to an area of over 7,000 acres. Wisconsin is now the first state in acreage and the quality is unexcelled. The cool, moist, autumn weather produces a soft fiber of superior strength. Seed cannot be normally matured in Wisconsin, but promising experiments in breeding an Italian type are being made.

Cooperative Marketing Wins

Cooperation between growers does not automatically occur; cooperation between growers and manufacturers is less likely to develop. The hemp industry in this state affords, however, a striking exception to this rule. With the encouragement of the college the growers and millers have formed an association, known as the Hemp Order of the Wisconsin Experiment Association, the purpose of which is to promote the welfare of the hemp industry in all of its phases. A. H. Wright of the Agronomy Department is secretary of this order. He has also had direct charge of the cooperative investigations in this field.

The problems of producing this crop have offered comparatively little difficulty, but the stage between the grower and the spinner had not previously been organized and developed. Special attention has been directed toward the successful organization of breaking and cleaning mills, since it is realized that this constitutes the keystone of the whole structure, for unless the mills can be made financially and economically successful, the hemp industry cannot long survive. Special efforts have been made to assist in the development of efficient labor-saving hemp machinery, such as the hemp harvester and the gather-binder. The college has cooperated with manufacturing concerns which were financially able to experiment on this problem, and a number of important improvements have been perfected.

Much Money Saved in Purchasing Hemp Seed

As Wisconsin must rely upon outside seed, it is important to cooperate in the purchase of this necessity. In 1917 the southern seed dealers forced the price of hemp seed to the abnormal figure of $8 to $14 a bushel. The 700 hemp growers scattered over five counties in Wisconsin were at the mercy of the seed interests. Through the medium of the mills, however, it was possible to concentrate this business, and Mr. Wright was able to purchase between 5000 and 6000 bushels of seed at a greatly reduced price. Through this channel the seed has been distributed to the farmers at cost and transportation.

The reduction in the price of sisal this year has menaced the immediate future of the hemp industry, and special efforts have been made to secure a foreign market for Wisconsin fiber. Sample shipments are being tested out in the English market, and through special government action on the matter of freight rates it has been possible to send a carload shipment to London for testing in the English mills on a large commercial scale. The development of this new market has assisted in obtaining a satisfactory arrangement for the disposal of the Wisconsin crop, which this year will aggregate not far from $1,000,000.

A COLD-RESISTANT CORN

During the last six years breeding work has been carried on by B. D. Leith (agronomy) in developing a corn which is more resistant to cold than the ordinary varieties. This corn has been developed from the Golden Glow, by selecting ears the kernels of which had withstood slight freezing. Experiments were made with such seed where germination was carried on in ice boxes at a temperature of 10° above the freezing point. By continued selection along this line it has been possible to secure a strain that will germinate when planted about 10 days earlier than the usual corn planting time.

In 1917 plots of this strain were the only ones at the station that were fully mature at the time of the first killing frost in the latter part of August. In 1918 this corn again matured about one week earlier than the original parent type of Golden Glow.

Trials made with this strain in the northern part of the state have been exceedingly promising. A sufficient quantity of seed has now been secured with which to make more crucial experiments this coming year.

CARDINAL KING—AN EARLY RIPENING SPORT OF SILVER KING CORN

In our breeding fields some years ago there developed in a field of Silver King a red corn which was found to ripen materially earlier than the ordinary No. 7 or Silver King strain.

Starting with this sport, experiments in breeding this particular strain have been in progress for a period of eight years. The color of this corn is a dark red, and curiously enough, the strain so far has shown an earlier maturity than the parent strain, ripening some two to three weeks earlier than the ordinary No. 7. Only limited trials have so far been made at other points than on the station farm, but satisfaction has been reported. Seed now available will make it possible to test this much more extensively next year.

Salting Corn Aids Drying

In the fall of 1917 the premature frost in August resulted in the production of an enormous quantity of soft corn. Practical trials with the application of salt were reported as successful in maintaining the keeping quality of such corn and preventing mold. In order to test this theory, experiments were made by H. W. Albertz (agronomy) in which lime was applied at the rate of 12 pounds to each 100 pounds of corn and common salt was applied at the rate of 15 and 30 pounds to each 100 pounds of corn. Untreated corn spoiled readily, so that it could not be used for feed. That treated with lime also kept very poorly. Corn treated with 15 pounds of salt to each 100 pounds of corn kept well until May, but deteriorated later, while that to which 30 pounds of salt was applied was in good condition as late as July.

Renewed Attention to the Wheat Crop

The abnormal conditions prevailing for the last two years have greatly stimulated interest in the state in the wheat crop. The importance of spring wheat is shown by the fact that the acreage in this state was increased from 145,000 acres in 1917 to 333,000 acres in 1918. For several years B. D. Leith (agronomy) has been continuing work on developing an improved strain of the Marquis wheat, and a six-year average return of this type has shown a yield of 35.9 bushels per acre.

Wheat at the Branch Stations. The results of several seasons' work indicate that early seeding is essential for good yields; also, that excellent results may be obtained by the method of sowing wheat on corn stubble or pea stubble without plowing, if the ground is put in good condition by disking and harrowing. Winter wheat if sown early on well-tilled land has been more profitable on the average than spring wheat.

Tests relative to time, rate, and manner of seeding indicate that best results are secured if the wheat is planted early in September. Best results with reference to surviving the winter were secured with wheat that was drilled rather than broadcasted. The heavier seeding of two bushels to the acre survived severe winter conditions better than seeding with a bushel to a bushel and a half an acre.

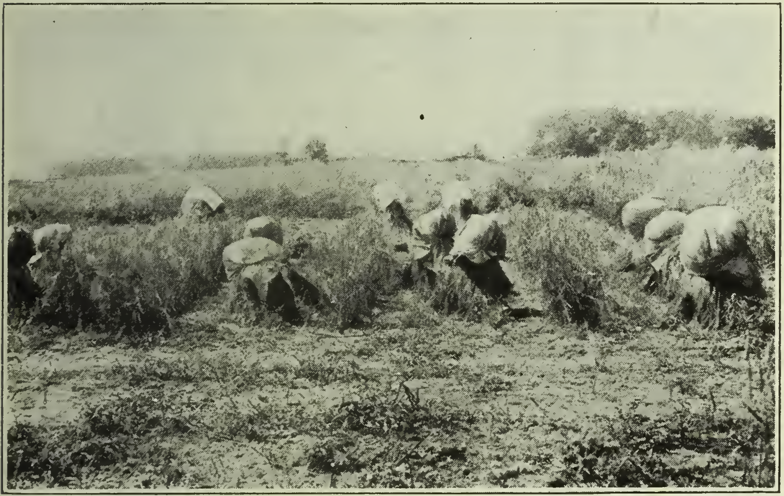


FIG. 16.—WHERE BETTER STRAINS OF WHEAT ARE BRED

Each strain must be cut separately and capped to secure accurate experimental results.

"CLOSE" THRESHING OF OATS INJURES VITALITY

Many growers resort to "close" threshing of oats, thus removing a considerable portion of the surrounding hull, leaving the oat grain more or less naked. This is done to remove the hulls and increase the weight per bushel. The removal of the protecting glume exposes the naked grain to unfavorable conditions in prolonged storage, and results in a marked deterioration of the vitality of the grain. Such practice also increases the susceptibility of the seed to attacks of disease.

Germination tests made by A. L. Stone (agronomy) indicate the marked decrease in the vitality of the naked compared with the covered grain.

IMPROVED VARIETIES OF FIELD AND CANNING PEAS GROWN

Two hundred twenty-five new varieties and strains of garden, field, and canning peas have been under cultivation at Ashland by E. J. Delwiche (agronomy) for the purpose of developing peas of early maturity, greater producing capacity, and improved quality. Of the canning peas, two purebred strains of the Horsford market garden variety have proved themselves to be of fine quality and especially adapted to the heavy Superior red clay.

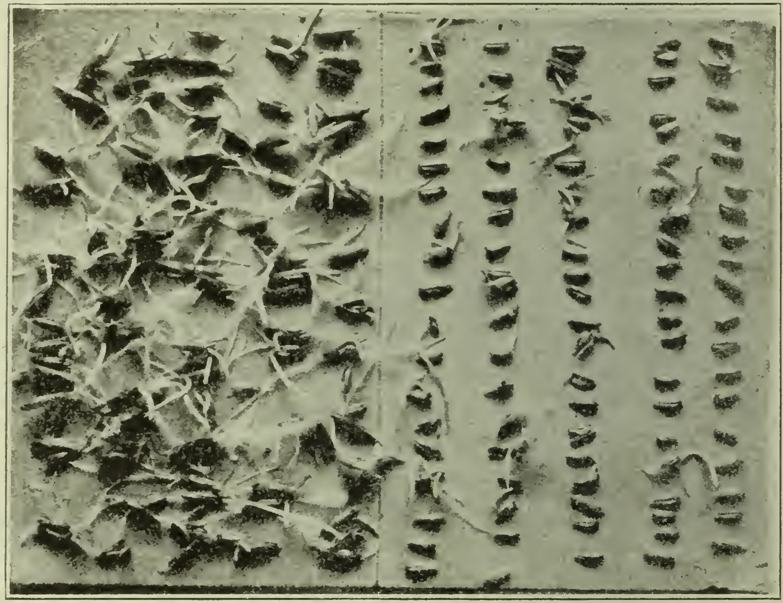

Covered Naked

FIG. 17.—CLOSE THRESHING OF OATS INJURES VITALITY

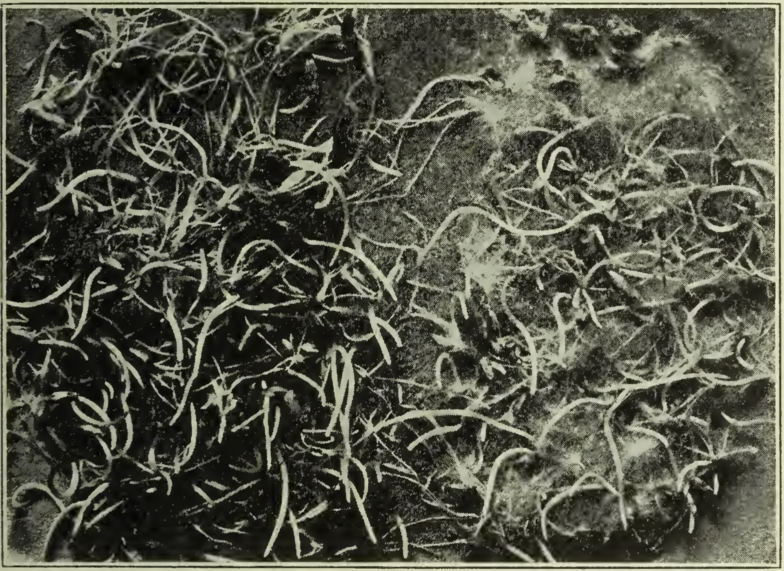
Seed of closely threshed (naked) grain (right) was largely killed in storage. Covered kernels protected by hull (left) all germinated.

BREED SORGHUM VARIETIES FOR WISCONSIN

The early frosts in the fall of 1917 destroyed much of the sorghum seed of the state. Over 90 per cent of the seed planted in the spring of 1918 had to be imported. This proved later to be badly mixed as to variety, and was also found to contain more or less kafir and other grain sorghums, broom corn, and sudan grass. A. H. Wright (agronomy) has given special attention for several years to breeding standard varieties. The interest in this subject has been greatly stimulated this last year by the sugar shortage.

STUDY WAYS TO PREVENT WINTERKILLING OF ALFALFA

Winterkilling continues to be the most serious drawback to the extension of alfalfa in this state. This condition not only causes loss by the actual destruction of the plant, and therefore by diminishing the stand, but it also reduces the yield by weakening the vigor of the growth of the surviving plants. L. F. Graber (agronomy) finds the two most successful ways to overcome this difficulty are:



Covered Naked

FIG. 18.—CLOSE THRESHING INCREASES DISEASE ATTACKS

Hull-less oats on the right were largely killed by mold attacks. The covered kernels on the left sprouted vigorously.

1. By cutting the crop not later than the first week in September in order to allow a sufficient fall growth to develop that will give protection to the roots during the winter.
2. By seeding hardy varieties, of which the Grimm, Baltic,

Cossack, and Turkestan are by far the most successful. This method gives much more successful results. Even these hardy varieties when cut late in the season are injured to a slight extent under our Wisconsin conditions.

In variety tests it often happens that the yield of the common strains is fully equal the first year to that of the hardy Russian and Asiatic strains, but the difference in hardiness which becomes more noticeable as the age of the alfalfa field increases, results in a material increase in crop of the Grimm and Baltic varieties after the first year. Much of the so-called hardy variety seed that is on the market is found not to be true to name.

While the best hardy varieties belong to the type producing variegated blossoms, still variation is not an indication of hardiness in the plant. Even the common alfalfa which under ordinary conditions produces purple blossoms, will produce variegated flowers in seasons of deficient rainfall. The alfalfa plant blossoms much more freely in dry weather, and consequently, the variations which may result in the production of variegated blossoms will be more evident where the field blossoms fully than where flowering is somewhat hindered by virtue of the increased rainfall.

Much trouble is frequently reported here in Wisconsin with reference to alfalfa being run out by blue grass. The idea prevails very commonly that ordinary blue grass will crowd out the alfalfa plants in the course of several years. Mr. Graber's experiments, however, are seemingly conclusive that the difficulty is due entirely to winterkilling and not to the elimination of the alfalfa by blue grass. In our experimental fields with common strains of alfalfa, where winterkilling ranged from 10 to 45 per cent, blue grass has come in rapidly to refill the barren areas, while under the same conditions with Grimm and Baltic, not more than 2 to 6 per cent of the area is occupied by grass. Farmers who practice late fall cutting or pasturing, especially if a severe winter season follows, will find much of their alfalfa stand ruined, and in time replaced with grass.

SUDAN GRASS IS PROMISING FORAGE CROP

For several years G. B. Mortimer (agronomy) has been testing the availibility of sudan grass as a forage crop. This relatively new forage crop promises well as a hay, especially when grown with soybeans, with which it thrives. One fact which hampers the spread of this crop is the excessive price which has heretofore been charged for seed. The station has attempted to develop seed which will mature in this climate. So far it appears that broadcasted seed ripens earlier and more uniformly than that which is cultivated in rows, due probably to the fact that when broadcasted the plants do not sucker as freely.

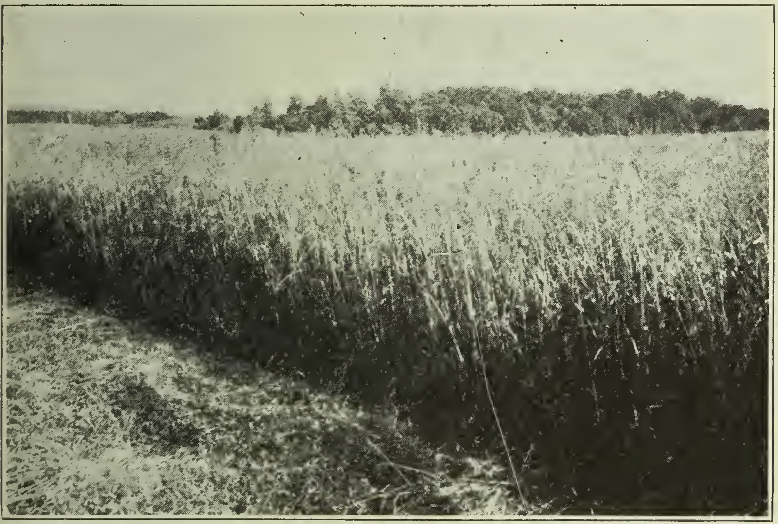


FIG. 19.—SUDAN GRASS IS A PROMISING HAY CROP

From two to three tons to the acre have been cut on the station farm, while from 1,000 to 1,400 pounds of seed were secured. Sudan grass thrives with soybeans and makes a good roughage.

As a forage crop, experiments on our station farm indicate a yield of 2.1 to 3.4 tons an acre, while from 1,000 to 1,400 pounds of seed to the acre have been produced.

EFFECT OF RESTING PERIOD ON GERMINATION OF SEEDS

One of the most serious problems in the testing of seeds is the unsatisfactory result which is often obtained in testing such seeds as winter wheat, winter rye, and timothy seed of the current season's growth which are to be used for fall planting. Seeds of this type require a resting period between harvesting and the time that they are used for seeding purposes. A. L. Stone (agronomy) has found that the germinating power of wheat, for instance, was increased fully 60 per cent by two months' storage after harvesting. Samples of timothy tested at frequent intervals for a period of four months showed an average increase in germinability of 36 per cent. Obviously this matter is of considerable importance, as an early germination test would give unfair results in that it would not represent the conditions as they would actually develop in practice.

NATURE OF CHEMICAL CONSTITUENTS OF CERTAIN VEGETABLE OILS

For seven years experimental work on the pure-line selection of soybeans has been under consideration by the Genetics and Agricultural Chemistry Departments. From 1912 to 1917 selections were made for high and low percentage of oil and high and low iodine number, to measure the relative value of the qualities of these oils for use in paint manufacture. The results of these selections have shown the ineffectiveness in breeding strains which would consistently show high and low oil percentages. In 1918 for the first time, L. J. Cole found the iodine numbers from the ''high-selection'' line were distinctly higher than those from the ''low-selection'' line. The average iodine number of 56 plants in the ''high'' line was 136.6, whereas that of 43 plants in the ''low'' line was only 125.1. As there is practically no overlapping in these high and low lines, this difference is apparently invested with considerable significance.

Further study will be necessary in order to determine the nature of this unexpected divergence, and especially its permanency. If this difference upon later study should prove to be of a permanent nature, it would seem to offer a beginning for the production of a really superior strain of soybeans that might yield an oil suitable for use in paint manufacture.

E. M. Nelson has studied the amount of and the iodine number of the oil in the leaves of soybean plants, and finds that in the leaves, as in the seed, these are subject to considerable range. The amount of ether extract, indicating a relatively low oil percentage, ranged from 3.7 to 6.0 per cent.

STUDIES IN NATURAL CROSS POLLINATION

In any plant breeding work either from the standpoint of scientific study or practically, it is extremely important to know to what extent plants naturally cross-pollinate under field conditions. Very few exact studies seem to have been reported on this matter. A definite knowledge of the inheritance of specific characters of a plant in question affords a means of making such a study and of checking the results on the basis of known characters. Progress has been made by the Genetics Department along these lines:

Soybeans. It has been assumed that about 1 or 2 per cent of natural cross pollination occurs in soybeans. Experiments by L. J. Cole indicate that it is probably much less frequent than that. Pure line strains with distinctive characters were planted alternately in the same row, and of over 6,500 pods examined, only three showed evidence of a cross.

Datura (Jimson weed). Similar experience with this plant showed a far greater amount of natural cross pollination. Using the stem color as a criterion, as this character can be readily determined in very young seedlings, from 19,000 seedlings grown for this test, 1.2 per cent developed purple stems, indicating crossing.

EFFECT OF SOIL MOISTURE ON EFFICIENCY OF DYNAMITE

Much variation exists in the cost of land clearing, depending upon the conditions under which explosives are used. Experimental results secured by J. Swenehart (agricultural engineering) indicate that it costs about 50 per cent more to remove stumps by the use of explosives during the dry part of the summer than it does in late fall when the soil is wet. Comparisons on the Kennan silt loam at North Crandon where 20 per cent dynamite was employed, indicated an average cost of 55 cents a stump under dry conditions as contrasted with 36 cents under wet conditions. Where stumps range from 50 to 100 to the acre, this material saving in expense is well worth consideration.

FARM LABOR PROBLEMS

Studies of farm labor conditions in the state by the Agricultural Economics Department show a rapid rise in wages of farm help when hired by the year. From a low valuation of $14 a month in 1866, farm labor in this state has increased to $26 in 1910, $36 in 1917, $43.50 in 1918. The continued scarcity of farm laborers as well as the high prices of farm products are, of course, explanatory factors in this recent rapid rise. The problem of the immediate future is that of adjusting the wage rate in such a manner that in the case of falling prices of farm products, the wage rate will not be beyond what the farmer can afford to pay.

The suggestion has been offered that wages might well be put on a sliding scale, with a guaranty of the 1915 wage scale and an agreement to pay up to the 1918 scale or even higher, in proportion to the prices at which the farmers sell staple products for 1915 prices or above. Such an arrangement no doubt would be equitable, but the question of assuming the risk of uncertainty is in all probability one which would militate against the introduction of the system.

FARMERS' LABOR INCOME UNDER PRE-WAR CONDITIONS

For five years farm survey records have been kept by the Agricultural Economics Department of all of the farms in Verona township in Dane county. The results show the principal crops grown were corn, oats, and hay; the principal products sold, milk, cattle, and hogs. The incomes for the first three years, from 1913 to 1915 inclusive, were low, but in the main, rose to a satisfactory level in 1916 and 1917. The accompanying chart indicates the labor income of each of the 60 farms, and shows a wide range in income of different farmers which is explained largely in the inherent differences in the ability and character of the farm operator. It is a startling fact that while some men are making good labor incomes, which have been increased under war conditions, a number have actually lost money, even under war conditions.

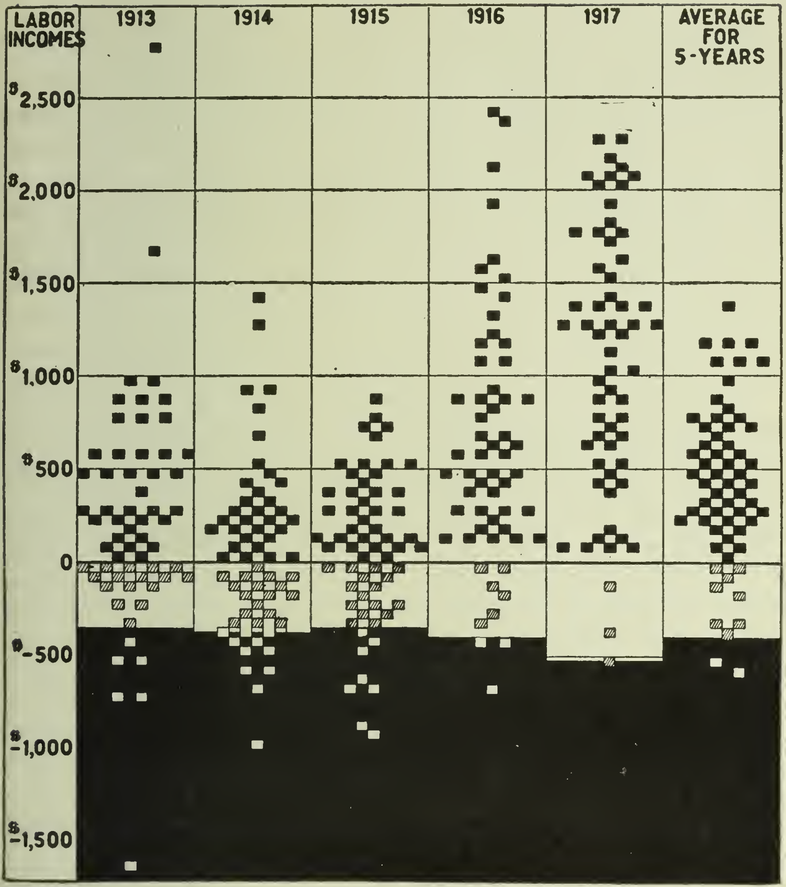


FIG. 20.—THE LABOR INCOME OF 60 VERONA FARMERS

With war prices most farmers prospered. In 1914 only seven had a labor income of more than $500 in addition to shelter and food furnished by the farm, while in 1917 the number was 46. The farmers whose incomes are indicated by the shaded dots received food and shelter ranging in value up to about $500. The white dots represent the farmers who lost money as well as their time.

Study Milk Marketing Problems

During the last year market milk studies have been completed and results published in detail by B. H. Hibbard and H. E. Erdmann (agricultural economics) in Bulletin 285. The general result of this work indicates that the farmer receives at different times from 50.5 to 62.7 per cent of the price paid by the consumer for bottled milk. The problems of reducing the cost of delivery have been experimentally studied this last year. In cooperation with a milk delivery company of Chicago experiments were undertaken in order to show how a unified system of delivery would result in a saving over the present method of milk delivery. These results indicated that the same amount of milk delivery work could be secured by about 55 per cent as many men and 37 per cent as many horses as are now used in the work. Such changes as these would result in a marked reduction in the cost of delivery to the consumer, which are now about one-fourth of the total cost of city milk.

HIGH SCHOOLS AND TRADE AREAS CLOSELY RELATED

High school districts, geographically speaking, are scattered over the entire country like ponds and lakes, here one and there one, while elementary school districts cover practically the entire area of the national map. In the main the high school has been regarded as an urban institution. C. J. Galpin (agricultural economics) has specifically studied the high school districts of the state, and finds when these results are platted that seven-eighths of the entire area of Wisconsin is outside of any existing high school district. This map discloses the fact that if the high school district were to be extended so as to cover the area from which its rural students come, it would practically coincide with the trade area of the village or city in which the high school is situated.

The elementary school district map makes plain that the particular group of country school districts around each village or city practically coincides with the village trade area, and therefore with the possible extension of the enlarged high school district. The logic of this situation indicates that if a closer relation existed between the country schools and their near-by high school, a larger proportion of country boys and girls would attend the village or city high school. A positive force would then enter rural life, cementing more securely the increasingly cordial relations of farmers and townsmen.

SOIL ACIDITY AND THE SEEDS OF PLANTS

It has long been recognized that an acid condition of the soil exerts an unfavorable effect on plant growth, particularly in the case of such plants as alfalfa and even clover. The common explanation has been that the soil acids exert a direct effect on the plant, or at least on the legume bacteria, but the recent work of E. Truog (soils) indicates that these acids prevent the plants from securing adequate amounts of lime from the soil to meet their needs. Some plants like alfalfa, clover, soybeans, tobacco, and sugar beets are exceptionally heavy lime feeders. Mr. Truog finds that when such plants do not get sufficient lime the plant saps become more acid, thus affecting growth.

Such plants as sugar beets, cabbage, rape, and barley, are as seriously affected as the most sensitive legumes, indicating that the harmful action is not directly due to an effect on the root bacteria.

In all soils, even when they are very acid, considerable lime is locked up in compounds not readily soluble. If carbonated water similar to the soil solution is used, lime may be extracted even from strongly acid soils. The stronger the acidity the less lime is it possible to extract from these sour soils.

The foregoing explanation also makes it possible to understand why plants are less affected by soil acidity in rich than poorer soils. In the more fertile soils, the processes incident to the growth of organisms are more active.

These findings now make it possible to determine by means of the Truog soil acidity test not only the relative degree of soil acidity but to recommend in a satisfactory way the amount of lime necessary to use to produce proper plant development. To these factors—the degree of soil acidity and the relative fertility of the soil—is to be added the lime requirement of each crop grown, not only as to amount but also as to the ease with which the necessary amount must be secured by the plant from the soil.

Alfalfa has a high lime content and rapid rate of growth, and only a medium feeding power; hence, its lime requirement is very high. Medium red clover has a lower lime content, grows more slowly, and has a stronger feeding power; hence, its lime requirement is lower. Oats have a low lime content and very strong feeding powers; thus, their lime requirement is low.

An acid condition of the soil indicates that the supply of available lime is becoming low, making it difficult for crops which have high lime requirements to secure the amount they really need unless the soil is limed. The higher the degree of acidity, the lower is the supply of available lime; hence, on such soils as these, it is more urgent that the lime be applied in sufficient amount.

Nature of soil acidity. Some investigators still hold that soil acidity is not due to the presence of real acids, but to the physical property known as adsorption. Mr. Truog and Mr. Pettis have taken an insoluble acid like stearic acid and subjected it, and acid soils, to treatment with various salt solutions. Such insoluble acids acted in a similar manner to acid soils in the treatment with salt solutions. In these treatments with salt solutions the effect of solvent and temperature have also been studied with results which indicate the existence of real acids to be the cause of soil acidity.

A NEW METHOD FOR TESTING FOR PHOSPHORUS

The importance of having accurate but cheap methods of determination in soil analysis is such that efforts have been made during the past year by Mr. Truog (soils) to devise a simple method of determining the phosphorus content of soils:

Briefly the method devised is as follows: The phosphorus is gotten into solution by igniting the soil with magnesium nitrate and digesting with nitric acid. The resulting solution is clarified by centrifuging. The phosphorus is then precipitated with ammonium molybdate in a specially designed tube in which, after centrifuging, the amount in per cent is read off directly. In this method the long and laborious operations of filtration, evaporation and dehydration have been entirely eliminated. A complete determination can be made in one hour. The old methods require a day or more.

As many of our Wisconsin soils respond markedly to phosphatic fertilizers, this method should be of much value in locating soils most in need of phosphate addition, as it has proved to be ideally adapted for use in connection with the State Soils Laboratory.

COLBY SILT LOAM NEEDS DRAINAGE

Colby Silt loam is a fine-grained, productive soil but it has a mechanical composition which results in a relatively poor subsoil drainage. At the Marshfield Branch Station the Soils Department has carried on tiling to study effects 1, 2, 3, and 4 rods from the tile. The most striking results were obtained with potatoes. An average for three years gave 163 bushels of potatoes on land 1 rod from tile with a gradual reduction to 121 bushels on plats 4 rods from tile. Yields of alfalfa and barley were also improved somewhat nearer the tile. The yield of corn stover on the plot 4 rods from the tile was 2,790 pounds while that on the plots adjoining the tile was 3,400 pounds, a gain of 22 per cent. The crop was frozen, so that no weights of ear corn were obtained.

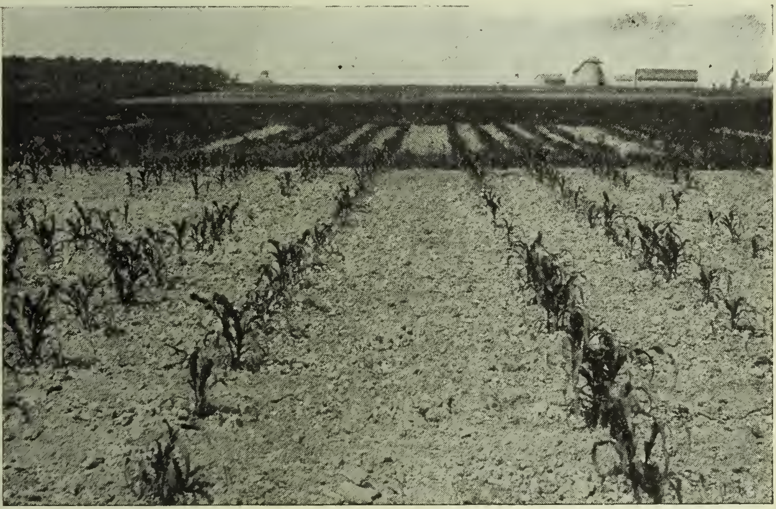


FIG. 21.—TILING FOR BETTER YIELDS

The wide strip through the center upper field is four rods from the lines of tile to the right and left. The poor underdrainage at this distance is shown by the missing hills and poor growth of the corn although the natural surface drainage on this portion of the field is as good if not better than on the lower field. (Compare with Fig. 22.)

MANAGEMENT OF SANDY SOILS

The large extent of sandy soils in a number of counties in the state led the last legislature to take the important advance step of establishing a branch experiment station at Hancock. This tract is composed of medium sand (Plainfield) underlain with somewhat coarser sand, and has been under cultivation for 50 years or more. The particular tract used for this work has been farmed for the last 15 to 20 years by renters. The average yield of rye in 1915 was 5 bushels an acre, corn 20 to 25 bushels, and potatoes 75 bushels. No legumes had been grown for at least 10 years, and renters who had previously utilized 120 acres of this land were barely able to make a living.

Work was started by the Soils Department late in the spring of 1916, two rotations being planned. One was a three-year rotation of rye seeded to mammoth clover, hay the second year, followed by corn; the second was the same except that a fourth year was added in which soybeans were planted. The financial record as revealed in the crop returns for the last three years is shown here:

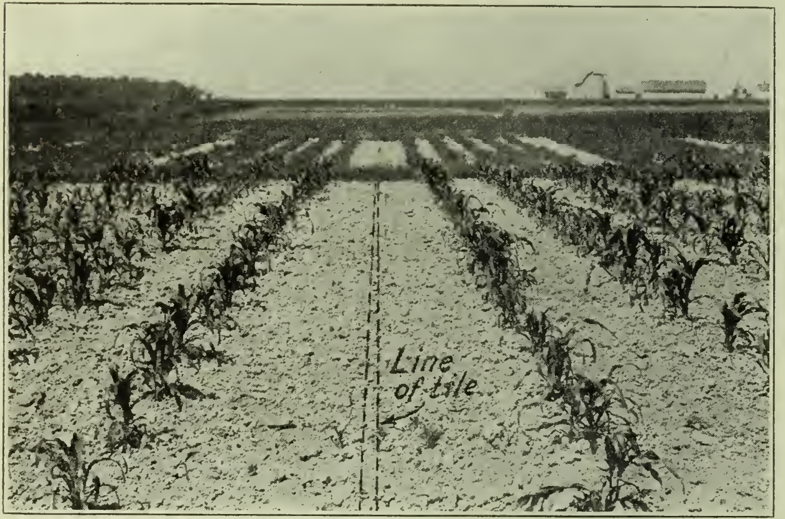


FIG. 22.—TILING IMPROVES STAND

Where a single line of tile runs at a depth of between 2½′ to 3′ through the center of the field, the improvement produced by the better underdrainage of the tile is shown in the nearly perfect stand on the plots lying along the lines of tile. (Compare with untiled, Fig. 21.)

	1916	1917	1918
Labor	$540.00	$745.00	$960.00
Fertilizer	101.00	157.50	185.50
Lime	65.00	121.00	74.50
Seed	130.00	145.00	255.00
Total expenditures	$836.00	$1,168.50	$1,475.00
Crop returns	240.14	720.00	1,520.00
Profit or loss	—$595.86	—$448.50	+$45.00

The foregoing figures show at present an operating loss of nearly $1,000 in three years, which from the practical viewpoint would seem ruinous to the average farmer. An inventory of the soil assets, considering it from the standpoint of its producing ability shows, however, that this loss is fully covered by the increased value of the fertility of the land.

The result so far indicate that commercial fertilizers in connection with green manuring crops will produce a material increase in the yields of nearly all crops. The addition of lime has proved very beneficial in building up these acid soils. Clover can be grown successfully on these poor sandy soils, where lime and either commercial fertilizer or manure are used. Good clover crops mean good crops of corn or potatoes the following year. Yields of fall rye can be materially increased by using either manure or commercial fertilizer as a top-dressing early in the spring.

Soybeans have succeeded well as a catch crop for feed either alone or with corn, resulting in the addition of nitrogen to the soil, and for green manuring purposes.

It is evident that the sandy lands which are worn out through long continued cropping can be renovated so that crop yields returned therefrom are materially in excess of the increased cost of the fertilizers which must necessarily be used.

The weather conditions for the last three years have not been wholly favorable. In 1916, a frost killed the potato vines early in September so that no crop was obtained, and it seriously injured the soybeans and corn. During July and August, 1917 and 1918, drought injured some of the crops severely. An early September frost also injured the more tender crops. Clover and alfalfa were winterkilled in the winter of 1917–18.

The importance of such demonstrational work on soil types of this sort cannot be overestimated. When the work was started, many of the farmers in the vicinity were very skeptical as to the possibility of building up these light sandy soils at a reasonable cost but the experiment of the last three years has demonstrated to many in this community the feasibility of the plan under consideration.

MANAGEMENT OF THE SUPERIOR RED CLAY

The fine texture of the heavy red clay along the southern shore of Lake Superior makes it especially adapted to the raising of grass for hay and pasture as well as small grains, but it is not so well adapted to cultivated crops because of the difficulty of keeping it in good tilth. The experiments at the Ashland Branch Station by the Soils Department have been planned to determine the special fertilizer needs of this soil and methods of tillage which will tend to overcome the physical difficulties. With wheat following corn in 1918 better results were obtained upon the muck plots than upon clay, wheat yields ranging from 23.75 to 27.75 bushels an acre.

TILLAGE COMPARISONS ON SUPERIOR RED CLAY

Experiments with tillage involved a comparison of spring and fall plowing and a comparison of six-inch fall plowing with various other tillage methods. The tillage treatment was applied once in four years on land in corn. The use of the Spaulding deep-tilling machine in comparison with six-inch fall plowing gave an increase of 1.6 bushels with a 28-bushel to the acre barley crop in favor of the deep tillage method. Also, a marked increase in clover and timothy hay was noted.

Subsoiling compared with fall plowing gave a 4-bushel increase with a 30-bushel crop, in favor of subsoiling, while in the case of small grains fall plowing was decidedly better than spring treatment of the land. Clover and timothy, however, made a better growth on spring-plowed land than on that fall-plowed.

While the tillage experiments on the Superior red clay show a marked increase in favor of deep fall plowing, it is noteworthy that no such benefit over spring plowing has been observed on the Colby silt loams at the Marshfield station.

FERTILITY TESTS ON COLBY SILT LOAMS

The Colby silt loam is one of the most extensive and important types in central and northwestern Wisconsin. Occupying as it does 2,250,000 acres or 6 per cent of the total area of the state, it is of the utmost importance that adequate fertility trials should be carried out on the Colby loam.

Five-year averages on corn and oats are now obtainable at the Marshfield Branch Station. On plots treated with acid phosphate (750 pounds an acre) F. L. Musbach (soils) reports the increased value of five years' produce over untreated plots was $19.77 an acre from which should be deducted an expenditure of $8.63 for phosphate. The phosphate applied with the corn continued to show residual effects for the entire five-year period.

Tests with ground limestone applied with oats on new seeding showed that consistent increases persisted throughout the five-year rotation. An increase in crop amounting to $17.02 an acre for the five-year period was secured at an outlay for limestone of $4.40. In consideration of the low cost of limestone, it is one of the best materials to use for soil improvement on the Colby silt loam. Potash trials were also made but so far no appreciable results have been obtained, especially with corn and oats. Rock phosphate increases the yield of corn.

FERTILIZERS ON SAND

Fertilizer trials started by the Soils Department in 1917 on the sandy soils at Spooner included the use of manure reinforced with varying amounts of acid and rock phosphate, and the use of potash. The first year's trials with corn showed good results with manure, phosphate, and potash (6,339 pounds corn stover) compared with check plots (4,908 pounds). The residual effects of this application were also shown in the following year.

The oat crop this year was only about one-half of the normal due to lack of rainfall in June and July, but the best yield was obtained from the plot receiving manure and phosphate.

Experiments on this soil type with potatoes involved the use of manure with and without mineral fertilizers, and minerals with clover clippings to supply organic matter. Plots receiving no manure but only clover clippings for organic matter produced almost as well as those with manure.

WILL ALFALFA FEEDING INOCULATE MANURE?

The idea is common that if alfalfa hay from a well-inoculated field is fed and the manure distributed on other fields, the manure will serve to inoculate the new fields. It has been shown by E. B. Fred (agricultural bacteriology) that in the passage of material containing large numbers of nodule-forming bacteria through the digestive tract these bacteria are destroyed. It is possible that small particles of soil with adherent bacteria may be carried with the hay and become mixed with the manure, due to any feed not eaten by the animals being used for bedding. It is certain that any farmer who relies on this method of inoculating his fields will be disappointed.

INFLUENCE OF ACIDITY ON GROWTH OF LEGUME BACTERIA

The maintenance of soil fertility involves the use of legumes and the nodule-forming bacteria. These types working together can take a portion of the nitrogen needed by the plant from the air, a source of nitrogen on which the farmer can draw only by growing well-inoculated legumes. The conditions under which the bacteria will grow thus become as important from the standpoint of the farmer as those governing the growth of the plant.

A careful study by Mr. Fred and Miss Davenport (agricultural bacteriology) has shown that the bacteria associated with alfalfa are very sensitive to acid, as is the alfalfa plant itself, while the soybean and the lupine bacteria are far less affected by an acid reaction, as is well known in regard to the plants themselves. It thus seems clear that when the soil is favorable for the plant or is made so, it will also be favorable for the bacteria associated with the particular plant. This fact becomes of importance when there is considered the question of how long the bacteria will persist in the soil in the absence of the legume, a condition that occurs in any scheme of crop rotation in which a legume is included. The bacteria producing nodules on peas, common beans, and clovers also show the same relation to acidity as do these plants.

THE IMPROVEMENT OF MARKET MILK

There has been a great improvement in the quality of the market milk supplied to the consumer within recent years. The improvement has been far more marked in the large cities than in the smaller cities and towns. To such an extent has this been true that the quality of milk sold in New York and Chicago excels in healthfulness and in keeping quality that sold in places much closer to the point of production. This has been due in large part to the efficient inspection service maintained by the health departments of the larger cities. Through the work of the laboratories the producers of poor milk have been located and the field inspectors have then helped these producers to improve their product. Such a procedure is necessary in the improvement of the milk in any locality. The smaller cities have felt that they must follow the methods of the larger places. These have proved too expensive and hence, in most instances, nothing has been done. It would seem that the first step should be a survey of the field by a laboratory examination of the milk; the second, an educational campaign. The man trained in the technical laboratory methods is likely to be deficient in his knowledge of the practical field of milk production and in his ability to do the best field work, and is likely to demand a larger salary than some one who would be satisfactory for the field work, but unable to do the laboratory work as usually carried out. It would seem wise, both from the point of view of expense and of good accomplished, to secure a man fitted for the direct contact with the producer and provide him with a method that does not involve technical training, for determining the best quality of milk.

Methylene blue reduction test. Such a method, the methylene blue reduction test, has been in use in the Scandinavian countries but has never been used to any extent in this country because it has always been considered to furnish no adequate idea of the quality of the milk.

Some work done by the Agricultural Bacteriology Department shows that this method does measure as accurately as any of the more expensive and complicated tests now in use the bacterial content of the milk, which is the greatest factor in determining its quality. It would seem that this test will lend itself to use in the smaller cities that are desirous of improving their milk supplies and place them more nearly on a level with the larger cities, as far as their opportunity in this regard is concerned.

CAUSES AND PREVENTION OF "LEAKY" BUTTER

The movement of brine from within to the outside of a package of butter is spoken of as leakage, and butter in which this movement is especially pronounced is styled "leaky" butter. Butter of this type loses rapidly in weight, producing an excessive shrinkage. When leaky butter is retailed in print form, considerable brine is forced out, resulting in further decrease in weight. A. C. Dahlberg (dairy) finds that "leakiness" in butter is not affected by the churning temperature or by the moisture content of the finished product, but is due to the condition affecting the texture of the product. The conditions resulting in the production of an open texture are: the use of cold wash water, working butter in water, under-working butter, and highly salting it. These conditions increase the capillary spaces through which the water can pass and thus tend to facilitate leakage. When butter is stored in a refrigerator the contraction of the butter fat globules increases the capillary space, thus promiting leakage.

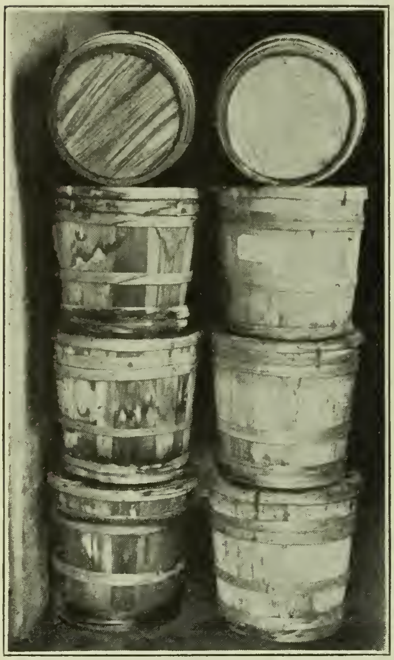


FIG. 23.—LEAKY BUTTER INJURES SALE OF PRODUCT

Butter packages packed with leaky butter (left) are badly discolored and depreciate in value rapidly.

PRIMOST (WHEY SUGAR) AS A SUBSTITUTE PRODUCT

Primost consists of the residues obtained by boiling whey. This product, concentrated, keeps well, and has the advantages of replacing a certain amount of cane sugar, especially when used in connection with glucose as a sugar substitute. Glucose, on account of its sticky physical condition, is hard to handle in the manufacture of candies, and J. L. Sammis (dairy) has found that a mixture of primost, which is much more granular, makes possible the use of glucose, where these lower-priced sugars are employed in the manufacture of candies. During the sugar shortage of the last year, the use of these sugar substitutes was found to be a matter of some economic importance. Such a product is an additional by-product which can be recovered from cheese factory whey.

WATER-PROOF GLUE FROM CASEIN

The necessity of securing water-proof glue for aeroplane purposes resulted in cooperative work between the U. S. Forest Products Laboratory and the Dairy Department last year. Heretofore the variations in the ash content and acidity in dried casein appear to have been the main cause of trouble in the use of casein in the manufacture of high-grade glue. The high acid and ash contents of many commercial caseins appear to be due to the use of excessive quantities of acid in manufacture, or insufficient washing of the curd before drying.

J. L. Sammis (dairy), applying the earlier principles which he had worked out on the influence of temperature and acidity on the curdling of milk, has been able to produce a fine grade of curd which possesses the physical properties that enable it to be washed and treated satisfactorily in the manufacture of glue. By heating skimmilk slowly to a temperature of 95° and acidulating it with sulphuric acid (1:5 solution), a curd has been secured which, when washed with water warmed to the same temperature as the milk, results in a product which can be readily pressed and dried. Upon chemical analysis this material has been found to be much more uniform in ash and acid content than caseins previously made.

Specifications prepared in connection with the United States government were in use for the commercial manufacture of this material for the production of water-proof glue at the time that the armistice was signed.

OFF FLAVORS IN DAIRY PRODUCTS

The study of the actions of metals on the constituents of milk has been continued by W. Pitz (agriultural chemistry), an account of the bearing which these have in the production of the so-called metallic flavors in butter. By subjecting casein or milk albumin to the action of hydrogen peroxide and iron sulphate in salt solutions, he has been able to isolate chemical compounds of a pungent, disagreeably smelling character, which have originated from the proteins of the milk. Under the influence of such oxidizing agents and in the presence of a metallic surface, decomposition by-products can be produced that are volatile in character and disagreeable in smell and taste and which impart an off-flavor in butter.

MAKE TESTS FOR JOHNE'S DISEASE

This very peculiar and persistent transmissible disease is a new menace to the livestock interests of the country. In other countries it has gained considerable headway. It is estimated that it causes a loss of from $2,500,000 to $5,000,000 annually in Great Britain. One of the livestock insurance companies of Denmark has paid annually losses equal to 3.5 per cent of the value of the animals insured in the case of 40 herds of purebred Jerseys. The disease is known to exist in several localities in this state. Until recently it has been impossible to detect its presence except by symptoms, apparent only in the more advanced stages of the disease. Due to the impossibility of recognizing the condition of the diseased animal until there had been great opportunity for it to spread to other members of the herd, the freeing of a herd from the disease was apparently a hopeless undertaking. The future success of some of our finest dairy herds has been seriously threatened by this disease. One owner has lost over a dozen animals in the last ten years. Five animals had to be removed from another herd in one year because of the disease.

The Agricultural Bacteriology and Veterinary Departments have been making some exceedingly interesting studies on this trouble. The method lately devised in England for the detection of the disease has been tried out. The organism causing the disease was isolated. A product called ''Johnin'' similar to tuberculin, was prepared by seeding a special culture medium with the organism and incubating the cultures for eight months. The organisms were then killed by heat and removed by filtration. This harmless product is injected into the blood system of the animals to be examined. In the case of an animal afflicted with Johne's disease a fever is produced as in the tuberculin test.

Five herds, four of which were known to have the disease, have been tested. One herd in Dunn County has been tested three times and reactions obtained at each test. Animals showing no apparent symptoms of the disease have reacted; these have been slaughtered and the disease found as evidenced by the characteristic intestinal lesions. The causal organism was found in such lesions.

It is too early to say whether or not this test will enable us to free a herd from the disease. This problem can be solved only through the cooperation of the livestock owners. We trust other cases of this malady may be reported to the station so that this new diagnostic method may be tried out as widely as possible.

TUBERCULOSIS IN HOGS INCREASES

Some interesting observations have been made by the Veterinary Science Department in regard to the occurrence of tuberculosis in hogs. A farmer living in Oregon, Dane County, reported he had lost from November to March, 17 hogs in a drove of 45. A sick pig brought to the laboratory for examination showed generalized tuberculosis. A survey of the farm showed that the pigs after weaning had been fed skimmed milk separated on the farm, ground feed, and corn, but had been allowed to follow the dairy cattle during the winter. Fourteen animals were slaughtered. Lesions of tuberculosis were found in 12. The lesions were so extensive in four animals that they were considered by the federal inspectors as unfit for food.

The cows on the farm were tested. Eight out of 17 reacted, four of which were so extensively diseased as to be condemned as unfit for food.

Statistical evidence is constantly accumulating which shows that tuberculosis of hogs is on the increase. The data collected by the federal meat inspectors show that the ratio of tubercular to healthy hogs is three times as great as in 1911. The percentage of tubercular hogs at those abattoirs which draw their supplies from dairy districts is far greater than at those drawing their supplies from areas where hogs are not fed skimmilk or whey or allowed to follow feeding cattle, as is shown in the following figures collected by one of the large packing companies.

Milwaukee	24.3	per cent
Chicago	14.3	"
Omaha	9.4	"
St. Paul	5.4	"
Denver	3.1	"
St. Louis	2.0	"
Ft. Worth	0.8	"

When 9 per cent of the 40,000,000 hogs slaughtered show the presence of this disease, and 2 per cent of those slaughtered at Milwaukee are used only for grease, it would seem that it is time that this drain on our resources is grappled with heroically. This disease places an enormous tax on the meat-consuming public. When the burden is thrown back on the producer of hogs, as it should be, for he is in position to check this loss almost entirely by the use of methods known to be effective, he will bestir himself in the eradication of tuberculosis of hogs as well as the disease in cattle with which it is so closely related.

The pasteurization of whey is one phase of this work which every farmer feeding whey should forward as much as possible by seeing to it that the factory of which he is a patron pasteurizes its whey in an efficient manner.

GROWTH OF BABY CHICKS

In studying the effect of different factors on the growth of animals it is highly desirable to widen the experimental basis on which such work is prosecuted. For a number of years the Agricultural Chemistry Department has been studying these problems with reference to mammals. More recently, J. G. Halpin (poultry) and E. B. Hart (agricultural chemistry) have endeavored to raise baby chicks on compounded rations of purified food materials. Rations made of purified casein, dextrin, salts, butterfat, and a minimum amount of wheat embryo or alcoholic extract of milk powder have always failed. The use of the wheat embryo as a source of the water soluble vitamine may be open to criticism, on account of its inherent toxocity, and for that reason yeast has been substituted for wheat.

As the baby chick grows two or three time as rapidly as the baby rat, from present results it would appear that the demands for water soluble vitamine in the chick are unusually large. Where 2 per cent of yeast is adequate in water soluble vitamine content to produce a normal growth in the rat, it takes five to six times this amount for the baby chick. Success in this field has not yet been reached, but it seems worth while to continue in this direction, as the study of the food deficiencies in the raising of poultry which result in the common trouble known as "weak legs" cannot be attacked until we have as sound a basis for experimentation as now obtains with reference to the rat.

LIME REQUIREMENTS FOR POULTRY

Studies on the calcium requirements for chickens have been continued by J. G. Halpin (poultry) and E. B. Hart (agricultural chemistry). Continuance of previous work has strengthened the conclusion that soft-shelled eggs are not due to a lack of lime, as is customarily believed. Best results have been secured where chicks have been fed oyster or clam shell in comparison with ground bone, calcium phosphate, or precipitated calcium carbonate in the mash. Inasmuch as the mussel shells, such as the oyster and clam, contain small amounts of iodine, attention has been directed to this aspect of the problem in order to determie whether the idodine content of mussel shells might not be the cause of their greater efficiency.

As a check on this iodine theory, potassium iodine has been added to lime rock grit as well as the calcium carbonate. No definite results can yet be reported, but at present pens getting calcium carbonate have not yielded quite as many eggs as those receiving the lime salt and potassium iodine.

Another possible explanation of the increased efficiency of shells is the physical condition of such lime salts in comparison with the more finely precipitated phosphate or carbonate of calcium. Experiments are therefore in progress in which the shell grit has been very finely ground in order to determine whether the mechanical size of the grit particle has any effect. The tentative progress results seem to indicate that the coarser particles are retained in the gizzard longer than the very finely divided material, thus giving an opportunity for the action of the hydrochloric acid for a longer period of time than in the case of the extremely finely divided material which readily passes through into the intestine.

EFFECT OF ORGANIC NUTRIENTS ON ANIMAL GROWTH AND REPRODUCTION

During the last year, the Agricultural Chemistry and Animal Husbandry Departments have continued their studies primarily on the influence of the oat plant, and, to some extent, of wheat by-products, on growth and reproduction. In the work last year with wheat by-products, it was shown that middlings, starch, and corn stover made a perfect ration for reproduction. This year bran was used in the place of middlings. When the amount of corn stover was reduced to 4 pounds in a ration of 14 pounds, in order to provide a proper protein intake, the disease known as miller's bran disease developed. This was characterized by stiffness, very rapid respiration, and miserably poor calves. Calves upon birth weighed only from 50 to 60 pounds, and lived but a few hours. The calcium content of the mother's blood was found to be unusually high, due to the excessive intake of magnesium and a low intake of calcium.

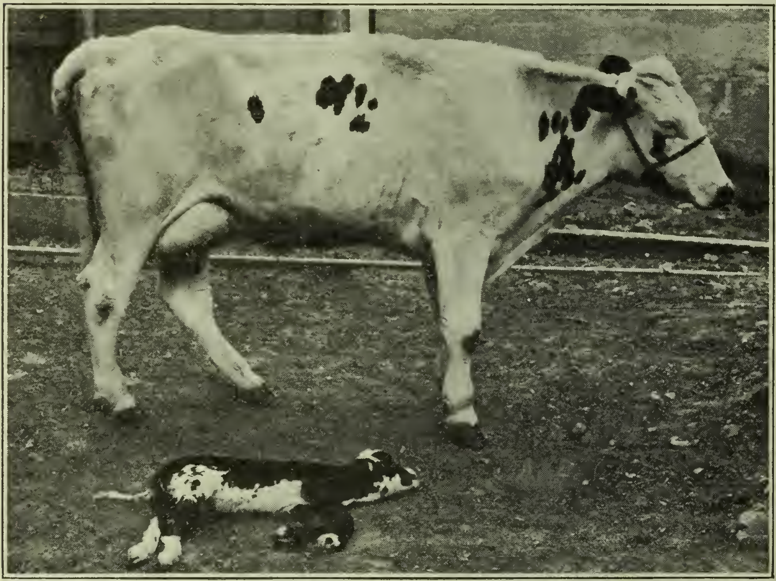


FIG. 24.—THE RESULT OF TOO MUCH WHEAT BRAN AND TOO POOR A ROUGHAGE

This cow was fed a mixture of 6 parts wheat bran, 4 parts corn starch, and 4 parts corn stover. Miller's bran disease developed and the cow aborted six weeks before calving time. Too much magnesium and too little lime resulted in intestinal poisoning.

The seat of this trouble is apparently to be found in a too low roughage supply, accompanied by an abnormally low mineral intake, and in a sense parallels the earlier experiments which were made with grain straws.

In every case where the oat plant was fed miserably poor offspring has resulted; for instance, with oatmeal and oat straw, and butterfat; oatmeal, casein, butterfat, and oat straw. This would seem to indicate that the trouble is not due to the poor protein or low vitamine content, but is a matter of actual deficiency in the mineral elements in the ration. Where the ration has been fortified with either calcium acetate or wood ashes, normal offspring has resulted. Further experiments are necessary to confirm this, but it is probably true that the main mineral constituent which is lacking is calcium. The working hypothesis which the departments are now studying is that a deficiency in the calcium intake disturbs the permeability of the intestinal wall. The blood stream of the mother may carry an overdose of the toxic materials which are present by virtue of the character of the nutritive ration to that extent that the young is poisoned by its influence. It does not seem likely that the defect is due merely to the lack of calcium needed in building of bone, but that a more subtle action, such as this toxic effect, is probable.

Oats fed with corn stover and other roughages carrying a high calcium content gave no trouble whatever. A good many of our grasses, such as June grass and timothy, as well as the straws, are low in calcium. Consequently, the importance of these as materials for roughage feeding of herbivora makes it highly desirable that this question be adequately studied. H. Steenbock has been studying the spinal cord of calves produced on this ration, and has found a marked absence or pronounced deficiency of the Nissl substance in the motor cells of the nerves, similar to the condition described in the annual report of 1916.

DIETARY PROPERTIES OF VARIOUS FOOD MATERIALS

The widespread use of barley during the war as a substitute for wheat led H. Steenbock and P. W. Boutwell (agricultural chemistry) to make a detailed study of the dietary qualities of this grain, especially as to its vitamine content. The results obtained indicate that barley does not differ materially from the other grains in the essential nutritive constituents. For growth it is primarily deficient in mineral elements, but these can be readily obtaned from common salt and lactate of lime. Its proteins are poor in quality and it is deficient in the fat soluble vitamine. Sixty per cent of barley in the ration suffice to furnish an abundance of water soluble vitamine for growth, and even allows reproduction.

Similar studies have been carried on by the same staff members on the presence of the fat soluble vitamine in roots and tubers. Most of these, such as sugar beet, and rutabaga, mangel, and potato have been found to contain less fat soluble vitamine than the grains. With root crops only the carrot was found to be richer. The use of roots and tubers exclusively in connection with the diet has resulted in a high content of indigestible and fermentable carbohydrates which in many cases induced digestive disturbances.

STABILITY OF VITAMINES

The importance of vitamines in the various animal and human foods has been prominently called to the attention during recent years. It is highly important also to realize what effect the various processes used in the preparation of foods exert upon these peculiar chemical bodies. H. Steenbock and P. N. Boutwell (agricultural chemistry) found in plants that the fat soluble vitamine is apparently quite stable. Finely ground alfalfa, incubated at blood heat with water in the presence of toluol and then dried, was found to suffice for normal growth as a source of fat soluble vitamine. With butterfat, however, the relations seem to be quite different. Four hours heat at the boiling temperature appeared to destroy entirely this vitamine.

MINERAL REQUIREMENTS OF ANIMALS

Ordinary feeds generally contain an excess of certain of the mineral elements such as potassium, magnesium, and phosphorus. H. Steenbock and P. N. Boutwell (agricultural chemistry) have determined what effect is produced on the growth of animals by withholding additions of the foregoing mineral elements when made in the form of complex salt mixtures. Both the magnesium and sulphate radicals were found to be indispensable, at least for growth. From this work it appears that not only are there deficiencies in rations due to the absence of certain mineral elements themselves, but it is highly probable that the inter-relations that obtain between different elements may offer a fertile field for investigation.

METABOLISM OF MUSTARD OILS

Infrequently loss of farm animals is occasioned from the ingestion of rape seed cake and other feeds rich in volatile sulphur oils. Under certain conditions these oils which in feed are in combination are so changed that a toxic condition of the material develops. W. H. Peterson (agricultural chemistry) has studied the influence of mustard oils in the metabolism of pigs. With an actual ingestion of over .5 of a gram of sulphur a day, the average increase in the urinary sulphur of such animals was about .14 gram. While slowly eliminated into the urine, it is in an unoxidized condition and apparently united with other substances in such a way as to reduce its toxicity. This fact is demonstrated by the observation that this oil cannot be distilled out of the urine. The experimental work indicates the absorption of these sulphur compounds, as there is very little volatile sulphur found in the feces. Apparently the compounds absorbed are slowly eliminated through the skin and urine in unoxidized forms, and in some cases so bound together as to greatly reduce their toxicity.

SYNTHETIC POWER OF THE MAMMARY GLAND

It is important to know whether the mammary gland has a special power of building up tissue. Previous studies have indicated that the protein mixtures used as feed differ markedly in their efficiency for milk production, and also in their power for growth. Working with rats on purified diets, E. B. Hart, N. E. Nelson and W. Pitz (agricultural chemistry) have studied certain substances (amino acid lysin) in order to determine whether a protein free from lysin will allow milk production to proceed. From the present results it appears that an animal can build its young in the absence of lysin, probably doing this from its own tissue, but that the secretion of milk or the rearing of the young by the mother cannot take place. From a number of records it is apparent that lysin must be present for continued milk secretion. It has developed that certain of the skimmilk powders, the alcoholic extracts of which have been used as a source of the water soluble vitamine, are really deficient in this necessary ingredient. This defect, however, was overcome by the use of yeast as a better source for this nutritional factor. If it should later be confirmed that dried milk powders have their water soluble vitamines destroyed at least in part by the application of the heat which is necessary in their process of manufacture, it is an important point.

HAIRLESS PIGS

In the experiments of earlier years, E. B. Hart and H. Steenbach (agricultural chemistry) have demonstrated that the physiological disturbance which resulted in the production of hairless pigs was associated with a deficiency in the iodine content of the feed. The treatment of sows, in which potassium iodid was added to the feed, has now been successfully used, not only in this state but elsewhere. A number of our breeders during the winter of 1917–18 experienced this hairless pig trouble. While the exceedingly cold winter and lack of roughage were undoubtedly contributing causes, the diet of animals may possibly be an additional important factor.

Experiments this year have been continued on the use of potassium iodid in the form of the salt, and also as found in oyster shells, which are relatively rich in iodine. It is highly desirable that some common and cheap material containing iodine be secured, although even at the present prices the chemical salt is not prohibitive. The suggestion is made that kelp, which is found in great abundance in the marine waters on the Pacific coast, might be used for this purpose, as this seaweed contains relatively large quantities of iodine, but the high cost of transportation under existing conditions is such that it would have no value over the use of the chemical itself.

Further experiments are in progress with reference to the study of this problem in its relation to the development of goiter. Its occurrence is so variable that we should have at hand all the factors contributing to its development.

GROWTH AND MAINTENANCE OF SWINE ON GRAINS AND ROUGHAGE SUPPLEMENTS

The earlier work in the Agricultural Chemistry Department showed that swine could not be grown on a ration made of grains alone, but where such feeds were supplemented with 15 to 25 per cent roughage, either in the form of clover or alfalfa, growth and physiological soundness were maintained. In this year's experiments sows that have been reared on grains and roughage with no disturbance whatever in reproduction had their roughage ration gradually reduced, thus increasing the percentage of protein in the diet. With mature sows normal reproduction developed where a ration composed of 10 parts of alfalfa, 40 parts of corn, 15 parts of oilmeal, and 35 parts of middlings was used. Later, the roughage was entirely removed, the mature animal being maintained wholly by the use of grains and their protein concentrates. It has been possible to secure at the first parturition successful reproduction and maintenance of physiological function with mature sows thus bed on a grain ration alone, fortified with no other material than common salt and the use of natural water. It may be that there is a marked difference between the relation of seeds to growth and their relation to maintenance, and that such factors as the content of mineral materials and vitamines of seeds which are used as grain feed, may be adequate for maintenance but inadequate for growth.

Here appears an interesting contrast between herbivora, such as cattle, and omnivorous animals, as the hog. It is impossible to have successful reproduction with the cow on cornmeal and a roughage low in mineral materials, especially calcium. The losses of mineral materials through intestinal excretions impose too great a strain upon such an animal as the cow. In the case of the mature sow, which has been fed concentrates, due possibly to the low excretory factor in this animal, there appears to be a sufficient amount of mineral substance retained, even in the case of corn, although this is well known to be exceedingly low in lime content.

Protein Storage by Swine

In the rearing of swine the roughage factor is extremely important from a physiological point of view. E. B. Hart (agricultural chemistry) has found, however, that roughage acts as a depressant in the matter of obtaining a high retention of nitrogen storage in the body. The poor and inefficient proteins of corn can be made more efficient by bringing into the ration 25 per cent of the total protein as milk protein, thereby increasing the efficiency of corn proteins from 25 per cent to 65 per cent. Whey proteins constituting only 16 per cent of the ration were found to increase the efficiency of cereal grain proteins from 25 to 47 per cent. The introduction of roughage, such as alfalfa, into the ration, however, lowers the efficiency of the corn-milk protein mixture from 65 to 45 per cent. Inquiries of this sort should establish the least amount of suitable roughage that can maintain physiological health, but at the same time lessen to the lowest possible point the amount of nitrogen which is excreted from the intestine.

Various Protein-Rich Concentrates for Milk Production

The comparisons of the efficiency of various protein-rich concentrates for milk production have been continued by E. B. Hart (agricultural chemistry) and G. C. Humphrey (animal husbandry). Gluten feed, linseed meal, corn distillers' grains, or cottonseed meal have been added to a basal ration of alfalfa hay, cornmeal, and corn silage. Earlier experiments had demonstrated that gluten feed had a low efficiency when coupled with cornmeal and corn stover, as compared with distillers' grains and linseed meal. This difference in efficiency disappeared, however, when clover hay was used as roughage.

This year experiments have been carried on with alfalfa hay, with the following results: Gluten feed and linseed meal were equally efficient with alfalfa hay. Distillers' grains had a greater efficiency than either of them, but cottonseed meal was the lowest in efficiency of any. The effectiveness of distillers' grains was unmistakable in all experiments. These facts suggest that in the absence of distillers' grains, an equally efficient protein mixture can be made from gluten feed and germ oilmeal, making a combination which would carry approximately 15 per cent of the latter feed.

The interesting observation was noted in these experiments that although the experimental animals declined in the volume of milk secreted, the composition of the milk was maintained unimpaired. In one case an animal lost 23 per cent of the total protein of her body and yet increased in live weight. This situation is perhaps somewhat analogous to the case of salmon which under the stimulus of reproduction may lose as high as 30 per cent of the protein in their muscle cells, without showing any cell degeneration, in their migration from the ocean to the head waters of the rivers which they seek in the deposition of their eggs.

FORAGE CROPS FOR PIGS

Trials to compare the value of various forage crops for pigs under southern Wisconsin conditions, have been continued by F. B. Morrison and G. Bohstedt (animal husbandry) at the Hill Farm. During the last three years pigs self-fed corn and tankage on rape pasture have returned $99.21 per acre of forage over the cost of corn and tankage fed. The same number of pigs self-fed corn and tankage with no pasture returned only $53.19 over cost of feed. Rape pasture, therefore, was worth $46.02 per acre.

In two years' trials a mixture of oats, peas, and rape has proved slightly more profitable than rape alone, yielding a return of $18.14 more per acre on the average. Red clover and alfalfa have been fully equal to rape, but not quite equal to the mixture of oats, peas, and rape. Trials are being continued to determine how many years a good stand of Grimm alfalfa will endure grazing by pigs under Wisconsin conditions and to find the best methods of pasturing alfalfa. Native pasture, consisting chiefly of June grass, with some white clover, has been much better than no pasture, but the return per acre in two trials has averaged $20.71 less than red clover. The last season first and second year white sweet clover has been tested, but has yielded somewhat less return than rape, red clover, or alfalfa.

VALUE OF BARLEY FEED AND BARLEY BRAN

With the wide use of barley flour during the war a large amount of the barley by-products became available for stock feeding. As no trials had been carried on to determine the value of these feeds, F. B. Morrison, G. C. Humphrey, and G. Bohstedt (animal husbandry) conducted a trial with 3 lots each of 6 cows, fed by the reversal method for 3 periods each of 3 weeks to compare the value of barley feed and barley bran with wheat bran. Barley bran consists chiefly of the hulls with some of the coarser particles of the seed coat of the barley kernel that are removed first in the process of milling. Hence, this feed is high in crude fiber, that fed in this trial containing 26.9 per cent fiber. On the other hand, barley feed consists of the bran together with all the middlings removed in milling barley flour. The barley feed used in this trial was the by-product resulting from extracting 55 pounds of barley flour from 100 pounds of barley and carried only 11.1 per cent crude fiber. Wheat bran, barley feed, or barley bran formed 30 per cent of the concentrate mixture.

When barley was fed the yield of milk was decreased 3.86 per cent from the yield on wheat bran. However, when barley feed was fed the yield of milk was decreased only 0.78 per cent. With wheat bran at $45 per ton barley bran was worth only $29.56, while barley feed was worth $42.16 per ton. Under war-time conditions, many farmers have paid much too high a price for barley bran, not realizing the difference in value between this and a good grade of barley feed.

In a trial by Messrs. Morrison and Bohstedt, barley feed supplemented with tankage proved satisfactory for fattening pigs, but did not produce as rapid or as economical gains as ground barley and tankage. With barley at 91 cents per bushel ($37.92 per ton), barley feed was worth only $31.58.

WINTERING BROOD SOWS

Experiment station trials as well as the experience of swine breeders have shown that corn alone is a poor ration for wintering brood sows, being too low in protein and mineral matter, and producing undersized, weak pigs. Some writers have gone so far as to state that corn should not form over one-third to one-half the ration for brood sows, as it is "too fattening." To study this question, as well as other problems in wintering brood sows, Messrs. Morrison and Bohstedt have fed several lots each of five pregnant gilts the last two winters. One lot was fed a mixture of 35 pounds ground corn, 30 pounds ground oats, 30 pounds wheat middlings and 5 pounds tankage (meat meal), this being a well-balanced mixture of the type preferred by those who do not like to feed a large proportion of corn to brood sows. This lot required 4.8 pounds per head daily of this mixture to keep them in the desired condition. Another lot was fed 4.2 pounds ear corn, 0.28 pounds tankage, and what alfalfa hay they would eat in a rack. They consumed 1.1 pounds per head daily the first winter and only 0.24 pounds the second winter. It will be noted that ear corn formed the chief feed of these sows. However, the corn was balanced by the addition of a small amount of tankage and alfalfa hay. The amount of corn feed was also limited to that needed to keep the gilts in thrifty, growing condition without becoming too fat. The pigs from these gilts were fully as large and strong as from the first lot where corn formed only 35 per cent of the ration. This shows that corn may form the main part of the ration for brood sows provided it is properly supplemented by feeds such as skimmilk, tankage, and alfalfa or clover hay, which are rich in protein and mineral matter, especially lime, and provided the sows are not fed so much corn that they become unduly fat.

Another lot fed merely ear corn and alfalfa hay gave good results, but each year the proportion of vigorous pigs was slightly smaller than where tankage was added.

CRUSHED VERSUS WHOLE OATS FOR WORK HORSES

Continuing previous work in which it was found that crushing oats did not make a saving of 10 per cent of the grain, Messrs. Morrison, Fuller, and Bohstedt fed one lot of work horses whole oats while their team mates were fed 95 pounds of crushed oats for every 100 pounds of whole oats the first lot received. Both lots were fed the same amount of hay. After 56 days, the rations were reversed and the trial continued for another period of 56 days. In each period the horses fed crushed oats gained very slightly more in weight than their team mates fed whole oats. Averaging both periods together, when fed whole oats the horses gained 5.2 pounds on the average and when fed 95 per cent as much crushed oats their average gain was 8.6 pounds. Thus, in this trial crushing oats saved just slightly more than 5 per cent of the grain.

The results of these two trials show that the saving by crushing or grinding oats for work horses whose teeth are kept in good condition is much less than has often been claimed, not amounting to more than 5 or 6 per cent.

PUBLICATIONS

Over 180,000 letters were written during the last two years by the station staff, most of which were in response to requests for information. Also, over 56,000 pages of manuscript material and 8,000 pages of stencils were prepared.

During the two years twenty-three bulletins, four research bulletins, fifty-five circulars of information and four poster bulletins were published. In addition, two bulletins, the supplies of which had been exhausted, were revised and reprinted.

Below is given a very brief digest of each of the publications issued under the auspices of the Experiment Station.

BULLETINS

Bulletin 271.—Rural Clubs in Wisconsin (C. J. Galpin and D. W. Sawtelle). Family clubs, men's clubs, women's clubs, and young folks' clubs play a large part in developing the community spirit and good neighboring, which are such great factors in good farming.

Bulletin 272.—Keep Our Hillsides from Washing (A. R. Whitson and T. J. Dunnewald) gives suggestions for the prevention of erosion, or soil washing, on Wisconsin farms.

Bulletin 273.—Distribution of Public Service Stallions in Wisconsin (A. S. Alexander). No less than 356 mongrel or scrub stallions have been retired from service in Wisconsin since the institution of the stallion law in 1906. A directory is given in the bulletin of the owners of public service stallions and jacks.

Bulletin 274.—Judging Dairy Cows (G. C. Humphrey). A man's ability to select profitable cows will always be a strong factor in worth-while dairying. This bulletin discusses the various points to be considered in judging dairy cattle.

Bulletin 275.—The Work of the Experiment Station and Agricultural Extension Service for 1916 (H. L. Russell, F. B. Morrison, and K. L. Hatch). A progress report on the year's work embracing the various lines conducted by the Agricultural Experiment Station, and of the extension work carried on by the Agricultural Extension Service.

Bulletin 276.—Correct Payment for Cheese Factory Milk by the Babcock Test (J. L. Sammis) describes the various methods of payment to be used in cheese factories, especial emphasis being laid upon the "Straight Fat" system.

Bulletin 277.—The Management of Tobacco Soils (James Johnson) gives practical information on managing the soil for tobacco culture. The average yield and quality of tobacco in Wisconsin has been decreasing, due partly to unwise selection and improper management of the soils.

Bulletin 278.—The Country Church an Economic and Social Force (C. J. Galpin). A study of country churches with examples in Wisconsin, and the life story of a great country pastor, John Frederick Oberlin.

Bulletin 279.—Fertilizers Sold in Wisconsin (W. H. Strowd) presents the annual list of the analyses of licensed commercial fertilizers for 1916, and gives information on the materials used for enriching the soil, as well as a summary of the fertilizer law.

Bulletin 280.—Potato Growing in Wisconsin (J. G. Milward). The production of potatoes, from the preparation of the soil to the harvesting of the tubers, is carefully outlined in this bulletin. The statements are based upon successful methods now in operation in the state.

Bulletin 281.—How Feed Inspection Helps the Farmer (W. H. Strowd) is the report for 1916 of the commercial feeds analyzed, together with a list of the licensed manufacturers, a treatise on the commercial feed law, and information on the feeds found on the market during that year.

Bulletin 282.—Cooperation in Wisconsin (B. H. Hibbard and Asher Hobson). Wisconsin is a leading state in agricultural cooperation. At least 12 cooperative lines of enterprise in Wisconsin are reviewed in this publication.

Bulletin 283.—Distribution of Public Service Stallions in Wisconsin (A. S. Alexander). Data has been compiled as to the distribution of purebred, grade, and scrub stallions throughout the counties of the state. The 1917 directory of owners of public service stallions and jacks is included.

Bulletin 284.—Tile Drainage on the Farm (E. R. Jones and O. R. Zeasman). Profitable farming of 7,000,000 acres of land in Wisconsin depends upon tile drainage. Draining thoroughly with tile costs less than draining with open ditches.

Bulletin 285.—Marketing Wisconsin Milk (B. H. Hibbard and H. E. Erdmann). The farmer receives about one-half the price the consumer pays for milk. This bulletin treats especially of the methods and economics of distribution.

Bulletin 286.—Control of Cherry Leaf Spot in Wisconsin (G. W. Keitt) discusses the cause and nature of the most destructive fungus disease of the cherry, and gives measures for its control by cultivation and spraying.

Bulletin 287.—New Facts on Feeding Cattle for Successful Growth and Reproduction (E. B. Hart, H. Steenbock and G. C. Humphrey). Balanced rations are often deficient in growth-producing elements, even though the supply of protein and energy be adequate. Mineral matter is of great importance in the ration, as are "vitamines," substances which are as yet unidentified chemically in foods.

Bulletin 288.—Rural Relations of High Schools (C. J. Galpin and J. A. James). This subject is divided into two parts—the social relations resulting from educating the farm boy and girl, and the relation of agriculture to the high school.

Bulletin 289.—Soybeans—A Crop Worth Growing (R. A. Moore and E. J. Delwiche). A discussion of the raising of soybeans for seed, hay, or forage. This promises to become one of Wisconsin's leading secondary crops.

Bulletin 290.—Farm Making in Upper Wisconsin (B. G. Parker and E. J. Delwiche). Practical hints for the settler in northern Wisconsin, as to the land to select, the buildings to erect, and the stock and crops to raise.

Bulletin 291.—Milk Necessary for the Nation's Welfare (E. B. Hart and H. Steenbock) discusses the value of milk as a food, particularly from the standpoint of supplying the vitamines so necessary for growth and reproduction.

Bulletin 292.—Price Fixing and the Cost of Farm Products (H. C. Taylor) gives the advantages and disadvantages of price fixing of farm products, with suggestions as to what points should be considered in fixing the price of any commodity.

Bulletin 293.—Wisconsin's Hemp Industry (A. H. Wright). Although comparatively new in Wisconsin, the hemp industry is of far-reaching importance. The production of the fiber in this state is fully discussed in this bulletin.

RESEARCH BULLETINS

Research Bulletin 39.—The Gain in Nitrogen from Growth of Legumes on Acid Soils (E. B. Fred and E. J. Graul). Experiments covering two years were conducted to study the growth and nitrogen-fixing power of various legumes on acid soil, including the influence on plant growth of inoculation and limestone.

Research Bulletin 40.—Some Economic Factors which Influence Rural Education in Wisconsin (Eugene Merritt and K. L. Hatch). A study of relationships between rural economics and education, and types of agricultural schools in Wisconsin in general, with a study of conditions in Iowa county in particular.

Research Bulletin 41.—The Utilization of Phosphates by Agricultural Crops, Including a New Theory Regarding the Feeding Power of Plants (E. Truog). A progress report on the most economical methods of phosphate fertilization and of maintaining the soil phosphates in a condition in which the crops may readily use them, under Wisconsin soil conditions.

Research Bulletin 42.—Early Blight of Potato and Related Plants (R. D. Rands). An intensive study of early blight as it has occurred in central Wisconsin during the past three years.

TECHNICAL ARTICLES

The following technical articles have been prepared by members of the station staff for scientific associations or technical journals.

Bachmann, F. M. A bacteriological method useful for the study of other microorganisms. Amer. Jour. Bot. **5**: 32. 1918.

——— The use of microorganisms to determine the preservative value of different brands of spices. Jour. Indus. and Eng. Chem. **10**: 121. 1918.

B. A. Beach and J. G. Halpin. Observations on the outbreak of Favus. Jour. Agr. Res. **15**: 415–418. 1918.

Binzel, Cora E. Suggestive outline of work on food conservation for home economics teachers. Pamphlet issued by C. P. Cary, State Superintendent of Public Instruction. March, 1918.

Bohn, Ralph. The iodine content of food materials. Jour. Biol. Chem. **27**: 375. 1917.

Cole, L. J. and Wright, W. H. Application of the pure lime concept to bacteria. Jour. Infect. Diseases **19**: 209–221.

Daniels, Amy L. and Loughlin, Rosemary. Feeding experiments with peanuts. Jour. Biol. Chem. **33**: 295–301. 1918.

——— and Nichols, Nell B. The nutritive value of the soy bean. Jour. Biol. Chem. **32**: 91–102. 1917.

——— and Strickler, Leola. A comparison of the digestibility of starch in typical batter and dough mixtures. Jour. Home Econ. **9**: 109. 1917.

Fred, E. B. The effect of certain organic substances on seed germination. Soil Sci. **6**: 333. 1918.

——— and Graul, E. J. The effect of soluble nitrogenous salts on nodule formation. Jour. Amer. Soc. Agron. **8**: 316–328. 1916.

——— and Davenport, Audrey. Influence of reaction on nitrogen-assimilating bacteria. Jour. Agr. Res. **14**: 317. 1918.

——— and Loomis, N. E. Influence of hydrogen-ion concentration of medium on the reproduction of alfalfa bacteria. Jour. of Bact. **2**: 629. 1917.

Fulmer, H. L. and Fred, E. B. Nitrogen assimilating organisms in manure. Jour. of Bact. **2**: 423. 1917.

Gardner, M. W. Dissemination of the organism of cucumber anthracnose. (Abstract) Phytopathology. **7**: 62. 1917.

Hadley, F. B. Protein therapy. Amer. Jour. Vet. Med. August, 1917.

Hart, E. B. and Humphrey, G. C. The relation of the quality of proteins to milk production, III. Jour. Biol. Chem. **31**: 2. 1917.

——— ——— Further studies of the relation of the quality of protein to milk production. Jour. Biol. Chem. **26**: 457. 1916.

———, Halpin, J. G., and McCollum, E. V. The behavior of chickens fed rations restricted to the cereal grains. Jour. Biol. Chem. **29**: 57. 1917.

———, ———, and Steenbock, H. The behavior of chickens restricted to the wheat or maize kernel, II. Jour. Biol. Chem. **31**: 2. 1917.

——— and Steenbock, H. Thyroid hyperplasia and the relation of iodine to the hairless pig malady. Jour. Biol. Chem. **33**: 2. 1918.

——— and Sure, B. The influence of carbohydrates on the accuracy of the Van Slyke method of the hydrolysis of casein. Jour. Biol. Chem. **28**: 241. 1916.

Harter, L. L. and Jones, L. R. Cabbage diseases. U. S. D. A. Farmers' Bul. 925. 1918.

Hastings, E. G. Milk clarification. Jour. Amer. Med. Assoc. **68**: 899–901. 1917.

——— Stable ventilation and tuberculosis. Hoard's Dairyman **53**: 472. 1917.

——— Cause and prevention of mold on butter. Rpt. Wis. Buttermakers' Assoc. 1916.

———, Beach B. A., and Hadley, F. B. The detection of Johne's disease by the use of Johnin. Jour. Amer. Vet. Med. Assoc. **52**: 462. 1918.

Hibbard, B. H. The utilization of land not in farms. Amer. Econ. Rev. **8**: 55. 1918.

——— Farm tenancy in the United States. Internat. Rev. of Agr. Econ. **8**: No. 4. 1917.

——— Grain exchanges and speculation. Nebr. Farmer, June 30, 1917.

Ibsen, H. L. Tricolor inheritance I. The tricolor series in guinea pigs. Genetics **1**: 287–309. 1916.

———. Tricolor inheritance II. The Basset hound. Genetics **1**: 367–376. 1916.

———. Tricolor inheritance III. Tortoise-shell cats. Genetics **1**: 377–386. 1916.

——— and Steigleder, E. Evidence for the death in utero of the homozygous yellow mouse. Amer. Nat. **51**: No. 612, 740–752. 1917.

Jones, E. R. Standard tests for drain tile. Proc. 3rd Conv. Wis. State Drainage Assoc. 1917.

———. Drainage to win the war. Proc. 4th Conv. Wis. State Drainage Assoc. 1918.

Jones, L. R. Disease resistance in cabbage. Proc. Nat. Acad. of Sci. **4**: 42–46. 1918.

———. Some recent advances in plant pathology. Sch. Sci. and Math. **17**: 95–100. 1917.

———. Truck crop diseases and their control. Florist. **47**: 544. 1916.

———. Disease resistance in plants. Seed World **3**: 345. 1917.

———. Graduate teaching and its relation to the work of the agricultural experiment station. 30th Proc. Assoc. Agr. Col. and Exp. Sta. **30**: 172–175. 1916.

———. Soil temperatures as a factor in phytopathology. Plant World. **20**: 229–237. 1917.

——— and Bailey, E. Frost necrosis of potato tubers, (Abstract). Phytopathology **7**: 71. 1917.

——— and Gilbert, W. W. Lightning injury to herbaceous plants. Phytopathology **8**: 270–282. 1918.

———— and Gardner, M. W. Lightning injury to crops, (Abstract). Phytopathology **8**: 80. 1918.

————, Johnson, A. G., and Reddy, C. S. Bacteria of barley blight seed borne (abstract). Phytopathology **7**: 69. 1917.

————, ————, and ————. Bacterial blight of barley. Jour. Agr. Res. **11**: 625–643. 1917.

————, ————, and ————. Bacterial blights of barley and certain other cereals. Sci. N. S. **44**: 432–433. 1916.

Johnson, A. G. and Coerper, F. M. A bacterial blight of soybean (abstract). Phytopathology **7**: 65. 1917.

———— and Davis, W. H. The aecidial stage of the red clover rust (abstract). Phytopathology **7**: 75. 1917.

———— and Hungerford, C. W. Scolecotrichum graminis on timothy, orchard grass, and other grasses (abstract). Phytopathology **7**: 69. 1917.

Johnson, J. The host plants of Thielavia basicola. Jour. Agr. Res. **7**: 289–300. 1916.

————. Wilt disease of tobacco attributed to Fusarium (abstract). Phytopathology **8**: 10. 1918.

———— and Hartman, R. E. Influence of soil temperature on Thielavia root rot (abstract). Phytopathology **8**: 10. 1918.

Keitt, G. W. Peach scab and its control. U. S. D. A. B. P. I. Bul. 395. 1917.

————. Second progress report on investigations of leaf spot of cherries and plums in Wisconsin (abstract). Phytopathology **7**: 75. 1917.

————. Third progress report on investigations of leaf spot of cherries and plums in Wisconsin (abstract). Phytopathology **8**: 72. 1918.

————. Inoculation experiments with species of Coccomyces from stone fruits. Jour. Agr. Res. **13**: 539–569. 1918.

Lippincott, W. A. The case of the Blue Andalusian. Amer. Nat. **52**: 95–115. No. 614. 1918.

Loughlin, Rosemary. Some recent investigations in nutrition at the University of Wisconsin. Jour. Home Econ. **9**: 546–549. 1917.

McCollum, E. V. and Pitz, W. Effects of feeding the proteins of the wheat kernel at different planes of intake. Jour. Biol. Chem. **28**: 211. 1916.

————, Simmonds, N., and Pitz, W. The dietary deficiencies of the white bean. Jour. Biol. Chem. **19**: 521. 1917.

————, ————, and ————. The supplementary dietary relation between leaf and seed as contrasted with seed and seed. Jour. Biol. Chem. **19**: 13. 1917.

————, ————, and ————. The nature of the dietary deficiencies of the oat kernel. Jour. Biol. Chem. **29**: 483. 1917.

————, Simmonds, N., and Steenbock, H. The method for the separation of the dietary essential, fat soluble A from butter fat. Proc. Amer. Soc. Biol. Chemists **4**: 26. 1916.

Nelson, V. E. and Beck, A. J. By-products in the fermentation of cabbage. Jour. Amer. Chem. Soc. **40**: 6. 1918.

Peterson, W. H. The metabolism of the mustard oils. Jour. Biol. Chem. **34**: 3. 1918.

Pitz, W. Studies of experimental scurvy. II. Jour. Biol. Chem. **33**: 3. 1918.

Roxas, M. L. The relation between amino acids and carbohydrates as a probable cause of human fermentation. Jour. Biol. Chem. **27**: 71. 1916.

Sammis, J. L. Testing cheese for moisture. Rpt. Cheesemakers Assoc. **1918**: 165–168.

Sauve, E. C. The selection of a tractor. Better Farming Jan. 1918.

Steenbock, H. Anti-neuritic substances from egg yolk. Proc. Amer. Biol. Chemists. **4**: 26. 1916.

———— The isolation of stachydrin from alfalfa hay. Proc. Amer. Assoc. Biol. Chemists **4**: 27. 1916.

Sure, B. and Hart, E. B. The effect of temperature on the reaction of lysine with nitrous acid. Jour. Biol. Chem. **31**: 3. 1917.

———— and Tottingham, W. E. The relation of amide nitrogen to the nitrogen metabolism of the pea plant. Jour. Biol. Chem. **26**: 535. 1916.

Tottingham, W. E. and Becker. Antagonism between manganese and iron in the growth of wheat. The Plant World **19**: 359. 1916.

Truog, E. Active and latent soil acidity vs. immediate and continued lime requirement. Jour. Ind. and Eng. Chem. **8**: 756. 1916.

————. The avidity of soil acids. Jour. Ind. and Eng. Chem. **9**: 1072. 1917.

————. Soil acidity: its relation to the growth of plants. Soil Sci. **5**: 169. 1918.

———— and Sykora, J. Soil constituents which inhibit the action of plant toxins. Soil Sci. **3**: 1917.

Truesdell, H. W. The effect of phosphorus in alfalfa and alfalfa bacteria. (Prepared under the direction of Dr. E. B. Fred.) Soil Sci. **3**: 77–98. 1917.

Vaughan, R. E. Truck crop diseases and how to control them. Trans. Ill. Hort. Soc. N. S. **50**: 329–333. 1916.

———. Cabbage diseases and their control. The Canner **44**: 112–113. 1917.

——— and Brann, J. W. Potato seed treatment (abstract). Phytopathology **8**: 70. 1918.

Walker, J. C. Studies upon the anthracnose of the onion (abstract). Phytopathology **7**: 59. 1917.

———. Control of the neck rot and anthracnose of onion sets (abstract). Phytopathology **8**: 70. 1918.

———. Notes on the resistance of onions to anthracnose (abstract). Phytopathology **8**: 70–71. 1918.

Wilson, H. F. A new species of macrosiphum. Ent. News **29**: 230–231. 1918.

——— and Gentner, L. G. The imported cabbage worm in Wisconsin. Jour. Econ. Ent. **11**: 79–81. 1918.

Zeasman, O. R. Tiling deep peat. 3rd Conv. Wis. State Drainage Assoc. 1917.

THE WISCONSIN AGRICULTURAL EXPERIMENT STATION, IN ACCOUNT WITH THE UNITED STATES APPROPRIATION

1916–17	Dr.	Cr.
To receipt from treasurer of the United States as per appropriations for the year ending June 30, 1917, under the acts of Congress approved March 2, 1887, and March 16, 1906	$30,000.00	
By salaries		$19,261.68
By labor		2,614.00
By publications		589.86
By postage and stationery		52.28
By freight and express		43.34
By heat, light, water and power		9.57
By chemicals and laboratory supplies		848.53
By seeds, plants, and sundry supplies		1,151.41
By fertilizers		481.35
By feeding stuffs		2,881.76
By library		
By tools, machinery, and appliances		347.71
By furniture and fixtures		285.53
By scientific apparatus and specimens		391.36
By live stock		225.90
By traveling expenses		766.62
By contingent expenses		30.00
By buildings and land		19.10
Total	$30,000.00	$30,000.00

THE WISCONSIN AGRICULTURAL EXPERIMENT STATION, IN ACCOUNT WITH THE UNITED STATES APPROPRIATION

1917–18	Dr.	Cr.
To receipts from treasurer of the United States as per appropriations for the year ending June 30, 1918, under the acts of Congress approved March 2, 1887, and March 16, 1906	$30,000.00	
By salaries		$19,298.52
By labor		2,765.44
By publications		21.05
By postage and stationery		80.38
By freight and express		37.61
By heat, light, water, and power		36.40
By chemicals and laboratory supplies		1,163.54
By seeds, plants, and sundry supplies		1,178.63
By fertilizers		193.98
By feeding stuffs		2,929.33
By library		
By tools, machinery and appliances		230.84
By furniture and fixtures		95.79
By scientific apparatus and specimens		1,163.30
By live stock		3.50
By traveling expenses		801.69
By contingent expenses		
By buildings and land		
Total	$30,000.00	$30,000.00

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S. M. Babcock, *Emeritus* Agr. Chemistry
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B. A. Beach, Veterinary Science
G. H. Benkendorf, Dairy Husbandry
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Bernice Dodge, Home Economics
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E. B. Fred, Agricultural Bacteriology
W. D. Frost, Agricultural Bacteriology
. G. Fuller. Animal Husbandry
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. F. Graber, Agronomy
. B. Hadley, In charge of Veterinary Science
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. G. Hastings, In charge of Agr. Bacteriology
. L. Hatch, Agr. Education
. H. Hibbard, In charge of Agr. Economics
llen Hillstrom, Home Economics
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Bulletin 303 June, 1919

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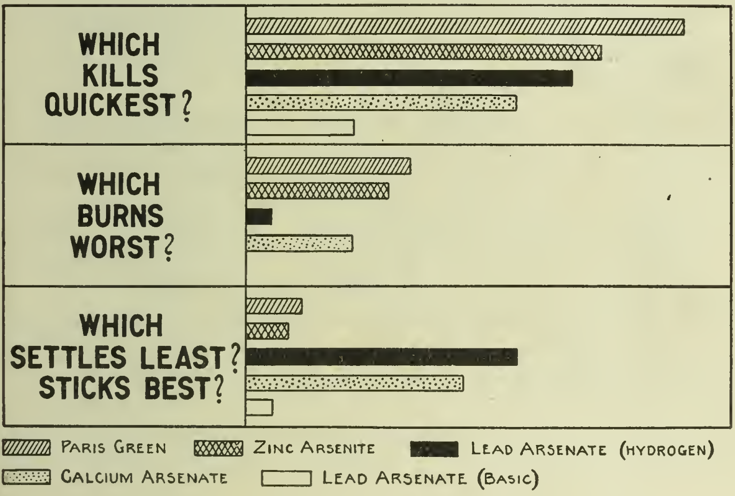
Common Insecticides

Their Practical Value

H. F. WILSON



USE THE BEST INSECTICIDE

The best spray is the one which burns the least, sticks best, and at the same time kills as quickly as possible. It is not necessarily the spray that kills quickest that is the best to use.

AGRICULTURAL EXPERIMENT STATION
OF THE UNIVERSITY OF WISCONSIN

MADISON

Insect pests which cause thousands of dollars of damage on Wisconsin farms can be controlled by the use of the right spray at the right time. Insect damage is usually a preventable loss.

There are a number of standard insecticides on the market as well as a large number of patented preparations. Which is best? The best insecticide is the one which burns the foliage of the plant the least, sticks best, and at the same time kills quickly. One spray may kill quickest, but burn the leaves heavily. Another may not burn the leaves, yet it will kill nearly as rapidly.

A careful reading of this bulletin and a short study of the drawings and illustrations, should help in buying the best insecticide.

Common Insecticides

Their Practical Value

Spraying is a very necessary part of farm practice for the control of insects on orchard, farm and garden crops. A cheap and efficient spray, easy to handle and easy to apply, is the desire of both grower and manufacturer. In other words, what is needed is a spray material that will kill quickly and at the same time involve a minimum of labor and expense for its application.

PRACTICAL EFFICIENCY DETERMINES VALUE OF INSECTICIDE

The value of an insecticide is based on its power to kill or to repel insects. To be considered ideal an insecticide should have these qualities:

1. It must kill the insect before the latter can seriously damage the plant.
2. It should possess no properties which will cause injury to the plant.
3. Its cost must be sufficiently low to permit its use in large quantities.
4. It must spread and stick well to the surface to which it is applied.
5. It must remain in suspension sufficiently well to permit of a uniform coating of poison on the sprayed parts.

COMMON INSECTICIDES HAVE SAME BASE

Arsenic oxide, the base of all important insecticides now used against chewing insects, is a substance which cannot by itself

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The data given in this bulletin are based on a series of tests made at the Wisconsin Experiment Station and at the Oregon Agricultural Experiment Station. Special attention is given to the comparative values of the insecticides used on potatoes as there is a large demand among potato growers for such information, and the crop is an important one in Wisconsin.

The amounts of poison necessary to give efficient control in the field were determined by comparative demonstrations on a seven-acre field at Waukesha in 1917 and a twenty-acre field at Hazelhurst, in 1918.

The spraying tests at Waukesha were carried on by the writer and those at Hazelhurst by L. G. Gentner. C. L. Fluke carried on the laboratory and field tests at Madison. In the laboratory tests, potted plants were used to some extent but were found unsatisfactory because of trouble in transferring the larvae. In the other tests fresh leaves dipped in the poison solutions were fed to the larvae and beetles in open glass jars.

The tests were primarily made to determine the comparative values of paris green, arsenite of zinc, arsenate of lead and calcium arsenate. Preliminary tests of other substances used in spraying for potato bugs were made, and the results are given in Tables I and II.

be used with safety on plants because of its tendency to burn the foliage. In combination with other substances, it acts as a poison to insects, but it does not cause harm to plants unless in a liberated form as arsenic oxide. The principal substances with which it is combined for spraying purposes are copper (paris green), zinc (in arsenite of zinc), lead (in arsenate of lead), and calcium (in calcium arsenate). These four poison sprays are the ones now mostly in use. A new material, arsenate of magnesium, has recently appeared on the market but its comparative value has not yet been tested at this station.

PARIS GREEN INJURES FOLIAGE

Paris green in comparison with other insecticides has a higher arsenical content than the other materials and a greater killing efficiency, but it is not an economical spray material at 50 cents to 80 cents a pound and it has a tendency to cause foliage injury. For these reasons, it seems that arsenate of lead is a much more desirable spray to use.

When paris green was first put on the market, it contained a comparatively large percentage of free arsenic oxide, but this has been considerably reduced through present methods of manufacture and in time it is possible that a paris green may be manufactured that will not injure the foliage any more than the other arsenicals. However, at present the percentage of free arsenic oxide is so great as to cause much more burning than is generally realized by our growers.

Paris green does not have the sticking qualities of the other insecticides nor does it stand in suspension as well.

ARSENATE OF LEAD DESIRABLE INSECTICIDE

Without question arsenate of lead is the most desirable poison insecticide on the market, and it is now more generally used than any other. The reasons are that, when properly prepared, it is safe to use on the foliage of practically all plants, it stands well in suspension, and it sticks and spreads well on the foliage. It does not have quite the killing efficiency of paris green but the difference is small in cases where pure arsenate of lead is used.*

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* It is necessary to point out that in these experiments, the so-called **hydrogen lead arsenate** and **not** the **basic lead arsenate** is indicated.

The insecticide manufacturers and chemists know arsenate of lead in two forms. In each one, the arsenic forms a different combination with the lead so that in the one known as hydrogen, acid, or diplumbic arsenate of lead, there are two parts of lead and one part of arsenic oxide forming a material with 33 per cent* poison in it. The second form of arsenate of lead known as basic, neutral, or triplumbic arsenate of lead forms a combination in which one part of arsenic oxide is combined with three parts of lead and in which the poison amounts to 25 per cent* of the total.

The basic lead arsenate forms a more stable combination between the lead and arsenic than does the lead hydrogen arsenate. For this reason it does not break down as rapidly in the presence of water or air and is the most desirable spray to use on tender plants in certain climates. However, this slow breaking down makes it an undesirable spray against those insects which are not quickly affected by poison.

The lead hydrogen arsenate is more easily broken down in contact with air, water or other chemicals and for this reason acts more quickly and has a higher killing efficiency than the other form. But for this very reason it is somewhat more dangerous to use on the foliage of tender plants. The present methods of manufacture, however, are such that the free arsenic in either one of the two forms is so limited that practically no injury results from the use of either.

The difference in the killing efficiency of these two forms probably accounts in a large measure for the unsatisfactory reports regarding the use of arsenate of lead to control the Colorado potato beetle. The basic arsenate is so slow in its action that very poor results are obtained when used against this insect, but lead hydrogen arsenate in small amounts gives immediate and efficient results. It has also been noted that, while insects that have fed on the basic lead arsenate do not die immediately, most of them become sick and do not feed after receiving a dose of the poison.

HARDY FOLIAGE WITHSTANDS ZINC ARSENITE

Arsenite of zinc has come on the market in recent years and next to paris green it seems to have a greater killing efficiency than any of the other insecticides given. However, it is somewhat variable in its action and its value is not fully determined. It seems that it cannot be used with safety on fruit trees because of its tendency to burn or crimp the leaves, but it has been found to be a very efficient spray for potato bugs, without causing injury to potato foliage. It should be slightly cheaper than arsenate of lead and would therefore make a very desirable spray to use on potatoes and other plants with hardy foliage.

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* Percentage refers to arsenate in powdered form.

CALCIUM ARSENATE GROWS MORE POPULAR

Calcium arsenate is a material which has received some attention from time to time and the few early experiments in which it was used seemed to show that it was not a desirable spray because of its tendency to cause spray injury to tender plants and because it does not have the killing efficiency of arsenate of lead. More recent investigations have shown, however, that there are several forms of this material similar to those of arsenate of lead and that one of these can be used on the foliage of plants with comparative safety when small amounts of lime are added. According to market quotations it is cheaper than any of the other insecticides and it can probably be manufactured and sold at a still lower price than at present. In this case, it should prove a very desirable substitute for the other poisons against certain insects. It remains in suspension nearly as well as hydrogen lead arsenate and it sticks equally as well under unfavorable weather conditions. It is now being manufactured in large quantities by insecticide dealers so that growers should have no difficulty in securing the amounts needed. This spray undoubtedly has a place among our insecticides and will probably be widely used in the future.

SPRAYS ARE USED IN VARYING AMOUNTS

Paris green. If paris green is to be used for the potato beetle, it is not necessary to use more than 1½ to 2 pounds to 50 gallons of water or, stated in terms of acres, 1½ to 2 pounds an acre. In cases where these amounts do not prove efficient, poor results are due either to improper application or to a poor grade of material.

Arsenate of lead. This material comes in both paste and powdered form. The paste should be used twice as strong as the powder. For Colorado potato beetle use 2 to 2½ pounds of the powder to every 50 gallons of water or of Bordeaux mixture, if the latter is used in disease control. This amount should cover about one acre. For codling moth and leaf feeding insects on fruit trees, use 1 pound of the powder or 2 pounds of the paste to 50 gallons of water. For cabbage worms and other chewing insects on cabbage plants, use 1 pound to 50 gallons of water and add 1 pound of laundry soap to make it spread and stick to the foliage.

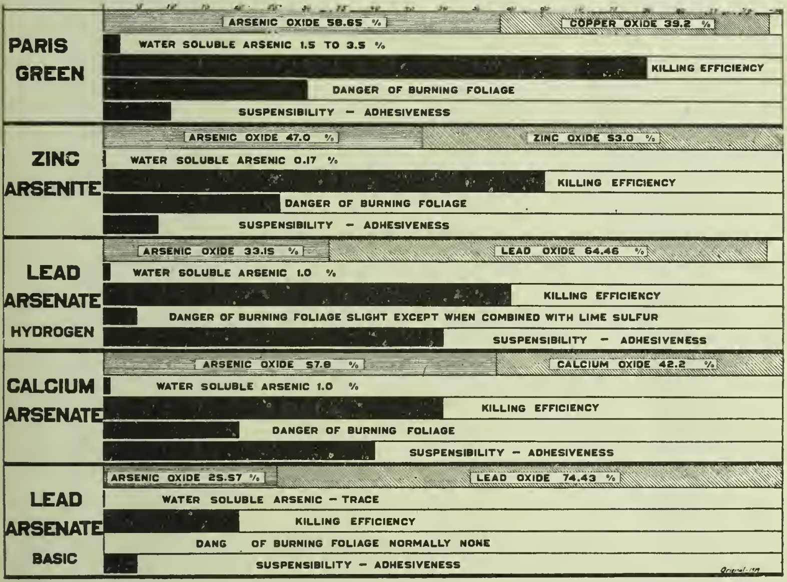


FIG. 1.—KNOW THE INSECTICIDE TO USE

Here are the five more important insecticides shown in comparison A study of this figure will show which is the insecticide for you to use.

Arsenite of zinc. Arsenite of zinc is sold either as a paste or powder, or as a paste combined with bordeaux and known as zinc bordeaux paste. For the Colorado potato beetle use 2 pounds of powder or 4 pounds of paste to each 50 gallons of water or bordeaux mixture. Directions for using the zinc bordeaux paste are given on the package.

Calcium arsenate. Calcium arsenate may be used in the same proportions as arsenate of lead but hydrated lime or unslaked lime is added in equal amounts to prevent burning. When the lime is added, it should be slaked in a small amount of water and poured into the spray tank before application. Calcium carbonate or air-slaked lime should not be used.

STIRRING IS IMPORTANT IN SPRAYING OPERATION

Figure 1 shows the average killing efficiency of paris green, arsenite of zinc, hydrogen lead arsenate, calcium arsenate and basic lead arsenate. The comparative values as shown are indicative rather than actual as new methods of manufacture have a tendency to improve the killing efficiency and to decrease the element of foliage-injury.

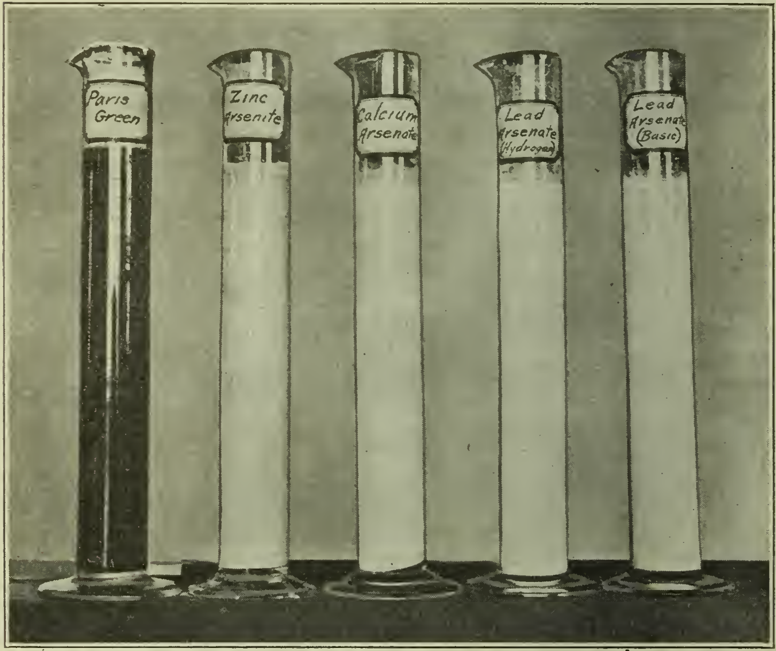


FIG. 2.—POISON INSECTICIDES NEED CONSTANT STIRRING TO PREVENT SETTLING

This photograph shows the comparative rate of settling of the common spraying materials immediately after shaking.

The rapidity with which a poison settles in the spray tank is of extreme importance because one of the difficulties of spraying is met with in getting a uniform spread of the poison over the plants. The five jars shown in figures 2, 3 and 4 each contain the same amount of water by volume and the same amount of poison by weight. The poison was poured into all five jars at the same time and the contents were immediately shaken; the second, third and fourth jars at the same time and the first and fifth a few seconds later.

The first photograph was taken immediately after shaking all of the insecticides.

The second photograph was taken three minutes later and shows not only the necessity of agitation in the spray tank but the comparative rapidity with which each one of these materials settles. Basic lead arsenate settles much more rapidly than any of the others although paris green is a close second. Zinc arsenite, calcium arsenate and lead hydrogen arsenate follow.

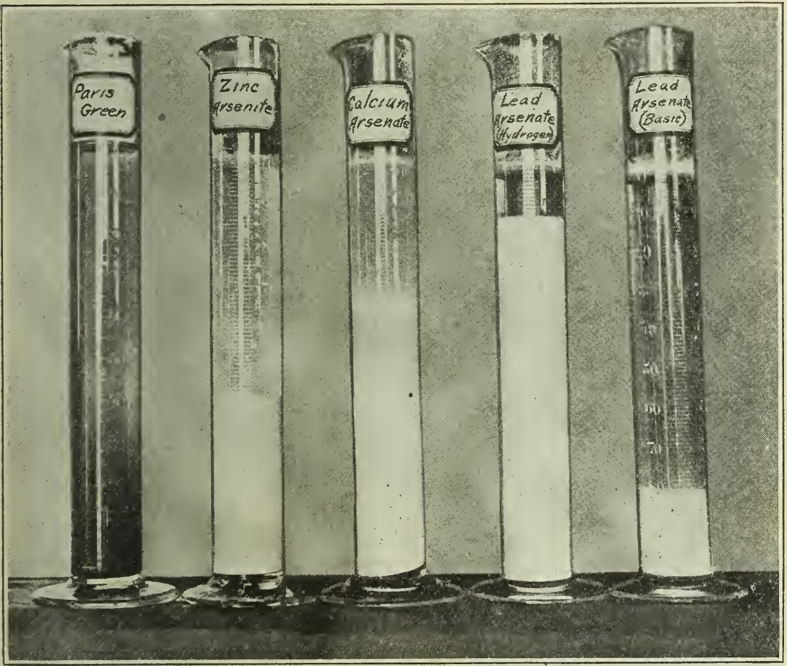


FIG. 3.—POISON INSECTICIDES NEED CONSTANT STIRRING TO PREVENT SETTLING

This photograph was made three minutes after the solutions were shaken thoroughly.

The third photograph was taken two days after the second and shows the volume and corresponding compactness of equal amounts by weight of each material, when settling is complete. This is important from the standpoint of agitation because it shows that the lighter and more fluffy the material, the better it remains in suspension and the easier it is to keep it agitated.

SIMPLE INSECTICIDES GIVE BEST RESULTS

Tests were made to determine the relative killing efficiency of some of our common insecticides and also to determine the active ingredients in others sold under trade names and containing a number of different chemicals. In all, 18 different materials were examined, including both simple arsenicals and proprietary insecticides and the materials used in their manufacture.

The materials were found to be of three classes:

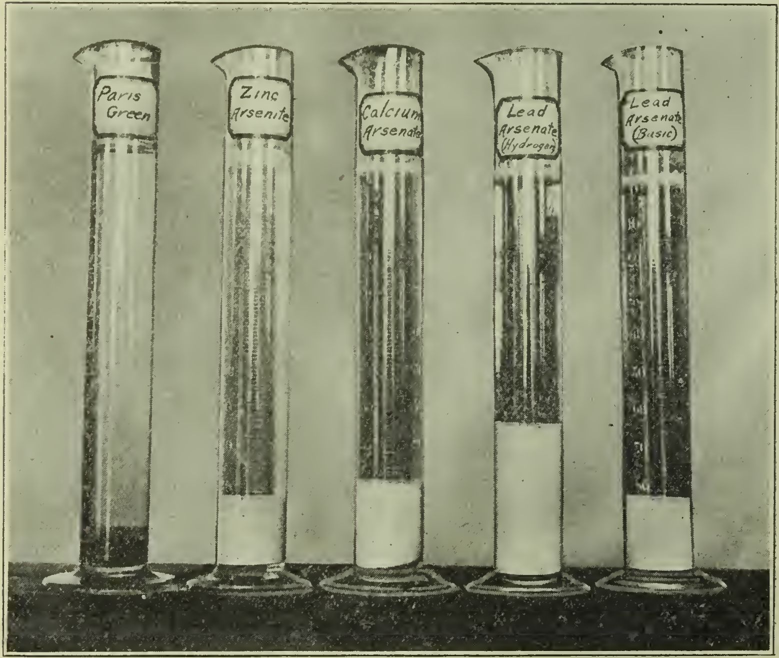


FIG. 4.—LEAD HYDROGEN ARSENATE SETTLES LEAST
The comparative volume and compactness of equal weights of the common poison insecticides photographed two days after shaking.

(1.) Those having no killing efficiency, (2) those having a slight degree of killing efficiency, (3) those having a high degree of killing efficiency.

In Class 1 are Prince's mineral, iron oxide and silica.

In Class 2 are basic lead sulphate, lead oxide, zinc oxide and the compounds of zinc oxide + lead oxide, and zinc oxide + lead oxide + iron oxide.

In Class 3 are paris green, lead arsenate, calcium arsenate, zinc arsenite, Bug Death, Kling Kill, Tuber Tonic and Insecto.

Paris green and a special brand of lead arsenate gave the best results with practically a 100 per cent killing efficiency within 24 hours. Ordinary arsenate of lead is second and zinc arsenite and calcium arsenate are a trifle slower than the others. The materials known as Bug Death, Kling Kill, Tuber Tonic and Insecto are proprietary compounds which contain as the active ingredient either lead oxide, zinc oxide or some arsenical compound. They are, therefore, merely diluted combinations of poison and have no advantage over a good grade of arsenate of lead or calcium arsenate.

Summarizing, paris green is the material with the greatest killing efficiency but it is little better than a certain brand of arsenate of lead. Ordinary brands of arsenate of lead, zinc arsenite, and calcium arsenate are a trifle slower in action but are sufficiently efficient for all practical purposes for the control of the Colorado potato beetle.

ADDITION OF LIME PREVENTS FOLIAGE INJURY

These tests were made primarily to determine the effect of each material used on the foliage of apple or potato plants. An effort was also made to determine whether or not there was any difference as to burning when the different chemicals were combined with lime or bordeaux mixture.

On potatoes, paris green without lime was the only spray which caused any marked damage. This is normally what happens in the field and is one of the reasons why growers are being advised to use a substitute for paris green.

On apple foliage it has been found that both calcium arsenate and paris green cause injury to the foliage unless they are combined with equal parts of lime, lime sulfur, or bordeaux mixture. When so combined, no burning has been detected.

TABLE I. LABORATORY INSECTICIDE TESTS TO DETERMINE KILLING EFFICIENCY

Test No.	Insecticide		Insect		Date started	Results												Remarks
						First day				Second day				Totals, third day				
	Name	Rate	Name	No.		Dead	Sick	Alive	Pupa	Dead	Sick	Alive	Pupa	Dead	Sick	Alive	Pupa	
1..	Prince's.. Mineral	19 gra. ½ gal.	Colo. pot. beetle larvae	25	June 19	....	......	25	0	3	2	12	8	....	....	......	......	Foliage all eaten
2..	"	"	"	100	" 24	2	2	91	5	......	......	......	......	....	....	......	......	" "
3..	Basic lead sulphate	"	"	25	" 19	....	......	....	......	2	......	20	3	5	....	10	10	Fed very little
4..	"	"	"	50	" 24	4	16	30	......	8	21	15	2	28	....	14	8	" " "
5..	Lead oxide...	"	"	25	" 19	....	......	....	......	2	3	20	0	11	8	0	6	" " "
6..	"	"	"	50	" 24	12	8	30	......	8	4	22	4	28	16	0	6	
7..	Iron oxide...	"	"	25	" 19	....	......	....	......	0	0	14	11	3	0	0	22	Ate all the foliage
8..	"	"	"	50	" 24	3	4	39	4	......	......	......	......	3	4	39	4	
9..	Silica.....	"	"	25	" 19	....	......	....	......	......	......	......	......	1	0	18	6	Not a killing agent
10..	Zinc oxide	"	"	25	" 19	....	......	....	......	2	0	20	3	10	3	5	7	Fed little
11..	" "	"	"	50	" 24	1	11	36	2	2	15	30	0	10	0	32	8	Fed considerable
12..	"Bug Death"	"	"	25	" 19	....	......	....	......	0	18	0	7	....	....	......	......	Fed little
13..	" "	26g-½gal.	"	100	" 21	....	......	....	......	......	......	......	......	43	0	41	16	" "
11..	" "	"	"		" 24	0	0	48	2	6	8	28	6	13	0	25	12	" "

15..	" "	dusted..	"	?	July	1	some	few	number	......	......	......	......	......	nearly all	some	......	......	Young larvae used
16..	Lead arsenate..	2—50	"	25	June	20	....	......	....	......	18	0	1	6	....	....	......	......	
17..	" "	"	"	100	"	24	72	23	0	5	10	11	0	2	93	0	0	7	{ Pupated ones did not feed
18..	" "	"	"	young	July	1	nearly all	......	1 or 2	0	all	0	0	0	....	....	......	......	
19..	Calcium arsenate	"	larvae..........	25	June	20	11	8	0	6	......	......	......	......	....	....	......	......	
20..	"	"	adults..........	25	"	20	6	4	15	......	19	2	4	......	....	....	......	......	Fed very little
21..	"	"	"	22	"	20	13	2	7	......	19	3	0	......	....	....	......	......	" " "
22..	"	1—50	larvae..........	100	"	21	....	......	....	......	......	......	......	......	68	1	0	31	Those pupated did not feed
23..	"	2—50	"	100	"	21	....	......	....	......	......	......	......	......	60	0	0	35	Alive; 5 dead in sand
24..	"	"	"	100	"	24	64	32	0	4	23	9	0	0	96	0	0	4	Fed very little
25..	"	1—50	"	100	"	24	70	25	0	5	18	7	0	0	94	1	......	5	" " "
26..	"	2—50	adults..........	40	"	24	34	6	0	......	4	......	2	......	39	1	......	......	Foliage scarcely touched
27..	"	"	saw fly larvae on willow	6	"	24	5	1	....	......	......	......	......	......	....	....	......	......	
28..	"	"	blister beetles.	25	Sept.	4	....	......	....	......	22	0	1		(2 m	issing)			Devoe & Raynolds — beet leaves
29..	"	"	" .	25	"	4	....	......	....	......	17	3	3	2	....	....	......	......	Corona-beet leaves
30..	Check....	"	" .	25	"	4	....	......	....	......	1	0	24	......	....	....	......	......	All active
31..	Zinc arsenite.	2—50	Pot. beetle (larvae)	27	June	20	21	4	1	1	......	......	......	......	....	....	......	......	
32..	"	"	" ..	100	"	24	67	33	0	0	18	10	0	5	95	0	......	5	
33..	Kling Kill	"	" ..	27	"	20	7	7	7	6	......	......	......	......	....	....	......	......	Fed very little
34..	"	"	" ..	50	"	24	7	19	21	3	23	15	0	3	45	0	0	5	
35..	Tuber Tonic...	2—50	larvae..........	100	"	24	77	23	0	0	13	5	0	5	90	5	0	5	
36..	Insecto...	"	"	100	"	24	44	43	9	4	23	19	9	1	67	19	9	5	
37..	Neutral lead ar..	"	"	100	"	26	1	0	99	0	38	......	54	7	39	0	54	7	

TABLE I.—Laboratory Insecticide Tests—Continued

To Determine Killing Efficiency

Test No.	Insecticide		Insect		Date started	Rdsults												Remarks
						First day				Second day				Totals, third day				
	Name	Rate	Name	No.		Dead	Sick	Alive	Pupa	Dead	Sick	Alive	Pupa	Dead	Sick	Alive	Pupa	
38..	Acid lead arsenate	2 -50	larvae..........	100	June 26	100	0	0	0	......	......	......	......	100	0	0	0	
39..	"	"	"	?	July 1	nearly all	......	2 or 3	......	all	......	......	......	......	......	......	......	Sprayed potted plants
40..	Special cal. ar..	"	"	100	June 26	73	23	0	4	15	8	0	0	88	8	0	4	
41..	Zinc ox.+ lead ox..	"	"	100	" 26	3	0	97	0	10	0	79	8	13	0	79	8	2 compounds
42..	Lead ox. +zinc oxide+ iron oxide	"	"	100	" 26	7	0	93	0	12	0	82	9	19	0	82	9	3 compounds
43..	Paris green ..	"	"	100	" 26	99	1	0	0	......	......	......	......	......	......	......	......	
44..	Cal. arsen. +iron ox.	"	"	88	" 27	62	0	24	2	24	0	0	0	86	0	0	2	2 compounds
45..	Lead ar. +iron ox.	"	"	68	" 27	50	9	0	9	6	3	......	......	56	3	9	......	2 "
46..	Check.....	"	"	25	" 19	0	0	18	7	......	......	......	......	3	0	0	22	

TABLE II.—SCORCHING TEST ON POTATO VINES—1918

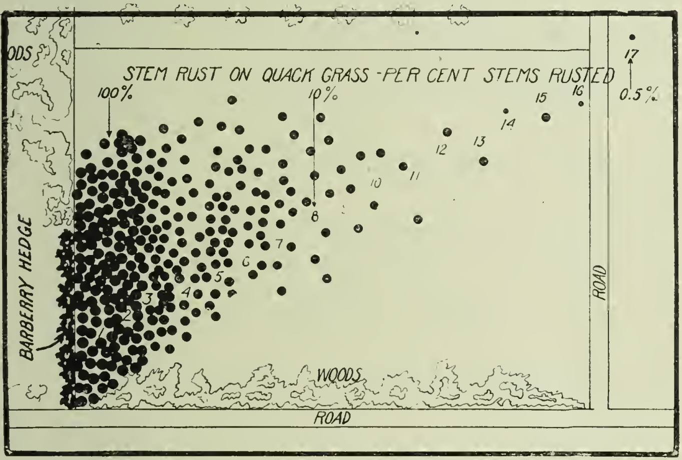
Plot	Insecticide Name	Insecticide Rate	Added Material Name	Added Material Rate	Date Applied	Effect on Potato Foliage	Remarks
1	Paris green	2-50			July 10 July 25	Lower leaves somewhat burnt	Rained July 26
2	" "	2-50	Lime	4-50	July 10 July 25	Vines uninjured	" " "
3	Arsenate of lead	2½-50			July 10 July 25	" "	" " "
4	" " "	"	Bordeaux	4-4-50	July 10	A few lower leaves and edges blackened	Injury apparently from Bordeaux
5	Calcium arsenate	"			July 10	No injury	
6	" "	"	Bordeaux	4-4-50	July 10	A few lower leaves seemed to be injured	Probably from Bordeaux
7	" "	"	Lime	2-50	July 10	No injury	
8	" "	"	"	4-50	July 10	" "	Plot 1 to 6 late
9	" "	"	"	6-50	July 10	" "	Varieties, rest early
10	" "	"	"	8-50	July 10	" "	Triumph
11	Arsenite of zinc	"			July 27	" "	
12	" " "	"	Lime	6-50		" "	
13	" " "	"	Bordeaux	4-4-50	July 10	" "	
14	Special calcium arsenate	"			July 10	" "	
15	"Tuber Tonic"	"			July 10	" "	
16	"Insecto"	"			July 10	" "	
17	"Kling Kill"	"			July 10	Slight indication of burning	Plot 18 injured more than 17
18	"Bug-Death"	"			July 10	Shows some burning	
19	Zinc-oxide	"			July 10	" " "	
20	Lead-oxide	"			July 10	No injury	
21 to 26	Checks					" "	Checks scattered among sprayed plots

Bulletin ~~430~~ 304

August, 1919

Stem Rust of Grains and the Barberry in Wisconsin

A. G. JOHNSON AND JAMES G. DICKSON



THE COMMON BARBERRY SPREADS STEM RUST

The stem rust spread from the infected barberry hedge to the grass in the adjoining field. All of the grass plants were rusted near the hedge. Therefore, the common barberry is dangerous and should be eradicated.

AGRICULTURAL EXPERIMENT STATION
OF THE UNIVERSITY OF WISCONSIN

MADISON

DIGEST

Stem rust of grains is a disease that has been known for centuries. Observations of farmers in many countries indicate that the presence of the tall or common barberry increases the loss from rust. Scientific study has shown that in one stage the stem rust passes to the barberry in the spring and from that back to the grains and grasses. Pages 3 to 4.

There are two types of rust: stem rust and leaf rust. The leaf rusts do not attack the barberry. Each rust has two stages, the "red rust" or summer stage and the "black rust" or winter stage. Infection on the barberry comes only from the black rust stage of the stem rust. Pages 5 to 6.

Each kind of grain has a different leaf rust caused by a different but closely related rust fungus. Pages 6 to 7

All grains are attacked by the same species of stem rust fungus. However, most of the grains have a specialized strain of the fungus which attacks only a limited number of grains and grasses. Stem rust causes enormous losses. The fungus, growing on the grain stems, causes them to split and considerable water is lost. Shrunken kernels result. Pages 7 to 12.

The tall, common or dangerous barberry is universally rusted in Wisconsin. Enormous quantities of rust spores are produced on the barberry leaves. No stem rust infections on grains or grasses have been seen before the time when such infection could have come from rusted barberries. Numerous early stem rust infections have been noted always close to rusted barberries. Pages 12 to 13.

Different kinds of barberries are found. The common barberry, either the green-leaved or purple-leaved varieties, harbors the stem rust. The rust is also found on the Mahonias, which are shrubs not widely planted in Wisconsin. The dwarf Japanese barberry does not carry the stem rust and is, therefore, harmless. Pages 14 to 16.

Stem Rust of Grains and the Barberry in Wisconsin

Commendable progress has been made in destroying the dangerous barberry in Wisconsin, but many bushes still remain. Information gained through the extensive rust and barberry survey of 1918 has shown that the barberry was much more widely distributed in Wisconsin than was at first thought. In some cases the barberry has escaped from cultivation and is growing wild. It is necessary, therefore, that if effective control of stem rust of grains is to be obtained through barberry eradication, the campaign so well started should be continued until the escaped, as well as the cultivated, bushes no longer exist.

The stem rust of grains is a disease caused by a fungus germ, a parasite, which is able to attack not only the grains, but also the ornamental shrub known as the tall or common barberry *(Berberis vulgaris)*.

This stem rust of grains has been known since ancient times as one of the serious grain diseases. It was the farmer, however, who first realized that the barberry was in some way connected with the rust. Farmers in England, Denmark, France, and America discovered at an early date that where barberry bushes were near their grain fields the grains were badly rusted and yields were poor. They even went so far as to pass laws prohibiting planting common barberry bushes near grain fields. Later the scientists took up the study and proved definitely that the rust on the grains and on the barberry was caused by the same species of fungus parasite. Furthermore, they discovered that the spores or seed bodies of this fungus parasite as they developed on the barberry in the spring, spread to the grains in nearby fields, and there caused the rust. Thus they showed definitely that the farmers' suspicions were well founded, and that the presence of the barberry was an important factor in spreading the rust to the grains in the spring.

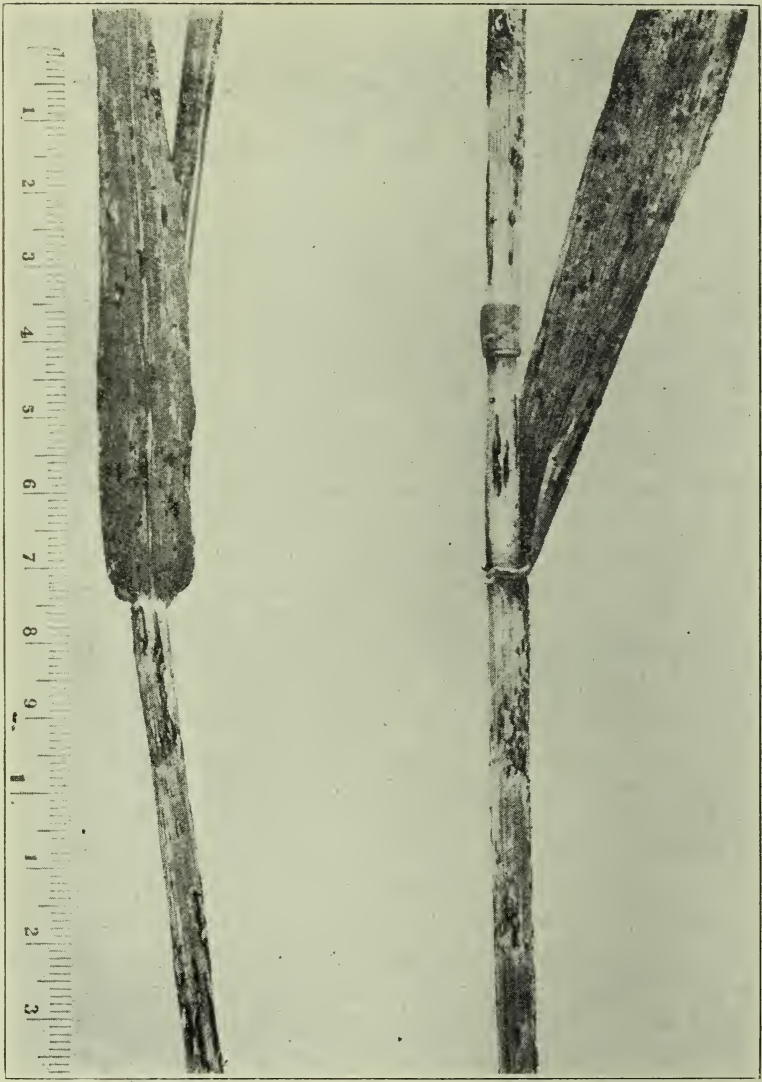


FIG. 1.—THE STEM RUST SPLITS THE SURFACE OF THE STEM AND LEAVES

The stem rust appears on the leaves and stems of barley, oats, wheat, rye and some grasses.

THERE ARE TWO TYPES OF RUST ON GRAINS

The various rusts of grains and other plants are caused by minute plants called fungi. The fungi grow within the grain plants somewhat similarly, in general, to the way the grain plants grow in the soil. Growing in this way, these rust fungi so sap the vitality or poison the tissues of the grains as to cause the diseases popularly known as the rusts.

In addition to the stem rust, which may occur on any of the cereals, there are leaf rusts, which also occur on the various grains. These leaf rusts are often confused with stem rust. They are, however, entirely different, and are caused by other species of rust fungi. None of these leaf rust fungi attack the barberry.

Each of these various cereal rusts has two so-called stages on the grains, namely, the "red rust" or summer stage and the "black rust" or winter stage. The "red rust" or summer stage occurs on the younger growing grain, while the "black rust" or winter stage develops later on the older grain, straw and stubble.

Only certain grains and grasses are attacked by the "red rust" stages of each of the various grain rusts. It is this stage of the rust that during the summer spreads the infection in the fields from the rusted grain and grass plants to those not rusted.

While the "red rust" stages of the various rusts spread the infection among the plants upon which they occur and also to certain other grains and grasses, these stages cannot infect the barberry or other similar plants. Only the "black rust" stages can do this. And in turn, the "black rust" stages cannot directly infect grains or grasses. These stages infect only other plants, widely different from those upon which they are produced, and from the infections on such plants the rusts may spread back to the grains and grasses again. For example, the "black rust" stage of the stem rust of grains *(Puccinia graminis)* lies dormant through the winter and infects the common barberry in the spring. From this barberry infection the rust spreads back to the grains and grasses. Similarly the "black rust" stage of the leaf rust of oats infects the common buckthorn *(Rhamnus cathartica)* and closely related plants. The "black rust" stage of the leaf rust of rye is able to infect still another plant. The plants that the "black rust" stages of the leaf rusts of wheat and barley may infect are not known.

LEAF RUSTS OF GRAINS CAUSED BY DIFFERENT FUNGI

The leaf rusts of grains are each caused by different but closely related rust fungi. Each of these fungi is able to attack and cause rust on only the one grain. The leaf rust of rye attacks rye and no other grain, that of wheat attacks wheat and no other grain, and so on. The leaf rusts differ in a number of ways from stem rust. The leaf rusts, as their name suggests, occur chiefly on the leaf blades and leaf sheaths. The "red

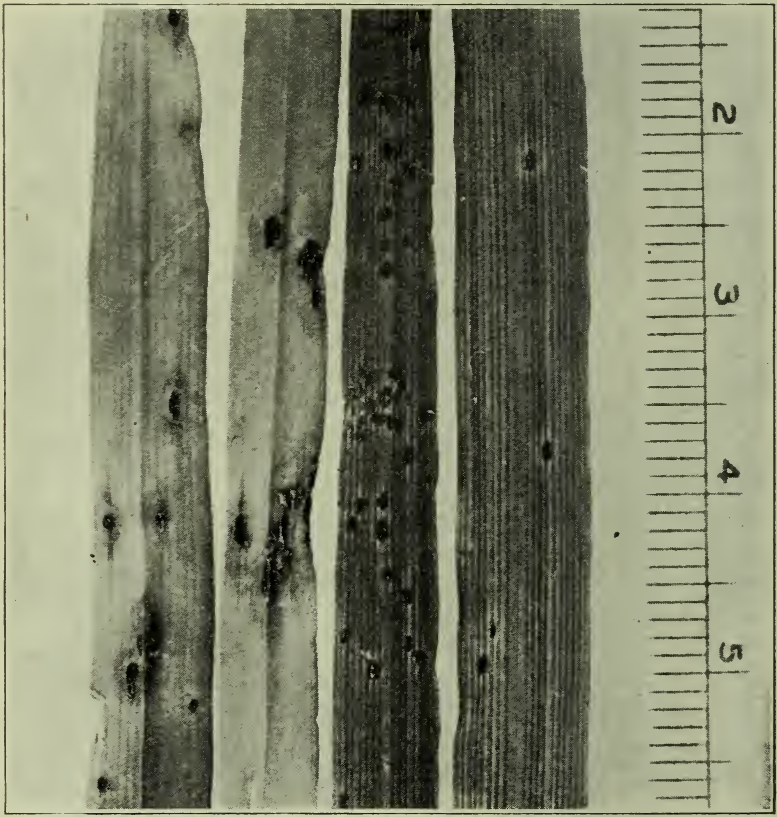


FIG. 2.—THE STEM RUST AND LEAF RUST ARE DIFFERENT

The stem rust on the leaves of winter rye (left) causes long lesions and splits the surface of the leaves. The leaf rust (right) causes small round lesions and does not split the leaf surface.

rust'' stages consist of small, almost circular pustules filled with an orange yellow powdery substance, the spores of the fungi. The leaf rusts do not split the surfaces of the leaves and sheaths so conspicuously as does the stem rust. The ''black rust'' or winter stages occur on the leaf blades and sheaths and are evident as rather small, smooth, grayish-black spots. These do not break through the surface as does the corresponding stage of the stem rust, figure 1. The differences between the ''red rust'' stages of the leaf rust and stem rust on rye are shown in figure 2.

BARBERRY SPREADS THE STEM RUST OF GRAINS

The stem rust of all the grains is caused by the same species of fungus *(Puccinia graminis)*. Most of the grains, however, have a so-called specialized strain of the fungus which is able to attack only a limited number of grains and grasses. For example, the stem rust strain on rye, barley, quack grass, and certain other grasses cannot attack wheat or oats. The stem rust strain on wheat attacks wheat, barley, squirrel-tail grass, and certain other grasses, but cannot attack rye or oats. Similarly, the stem rust strain on oats attacks oats and certain grasses, but cannot attack rye, wheat, or barley. Barley is the only grain, then, that is subject to the attacks of more than one of these stem rust strains, for both the rye and wheat strains may attack barley. On the other hand, barley is the only grain which does not have a stem rust strain specialized chiefly to itself.

All of these various specialized strains of stem rust can infect the common barberry in the spring by means of their ''black rust'' stages. And then in turn, each strain can spread from the barberry back to the same grain or grains and grasses to which it is specialized. That is, its specialization remains the same, even after infecting the barberry.

The ''red rust'' stage of stem rust occurs chiefly on the stems (fig. 1), but may also occur on the leaves of the growing plants (fig. 2). It is evident as rather conspicuous, distinctly elongate or oblong, reddish-brown pustules. These pustules are quite

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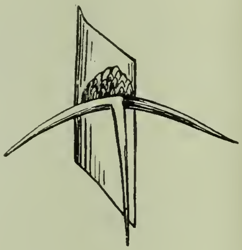
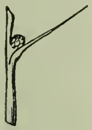
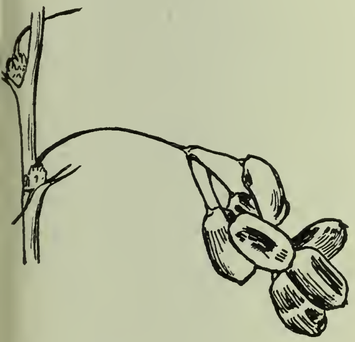
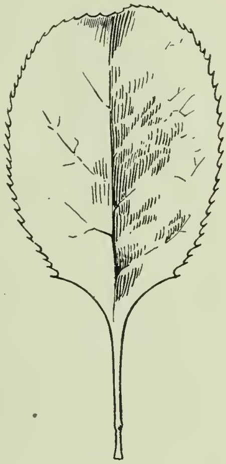
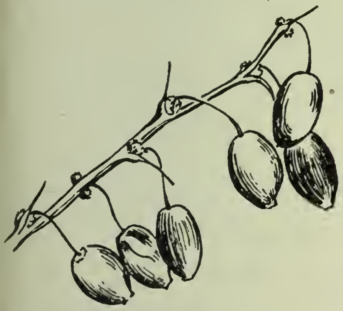
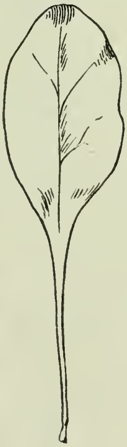
The leaf rust of rye is caused by the fungus known by its Latin name as *Puccinia dispersa;* the leaf rust of wheat by *Puccinia triticina;* the leaf rust of oats by *Puccinia coronata;* and the leaf rust of barley by *Puccinia simplex.*

TABLE II.—DISTINGUISHING CHARACTERIS

Kind of barberry	Habit of growth	Color of bark	Shape of spines
HARMFUL Common or tall European Barberry	Tall upright open habit of growth	Gray	Three-parted, large 
HARMLESS Japanese Barberry	Low, rather spreading dense habit of growth	Reddish brown	Simple, small 

HARMFUL AND HARMLESS BARBERRIES

Description of berries	Description of leaves
Oblong, shriveled, red to purple, borne in long clusters 	Rather large, sharply toothed margins 
Oval, plump, scarlet, borne singly or in pairs 	Rather small, smooth margins 

large and, as they break through the surface of the stem or leaf, cause marked splitting of the surface layers. This splitting and shredding of the surface is likewise characteristic of the "black rust" stage, which develops later in the season in the same or adjoining regions formerly occupied by the "red rust" stage.

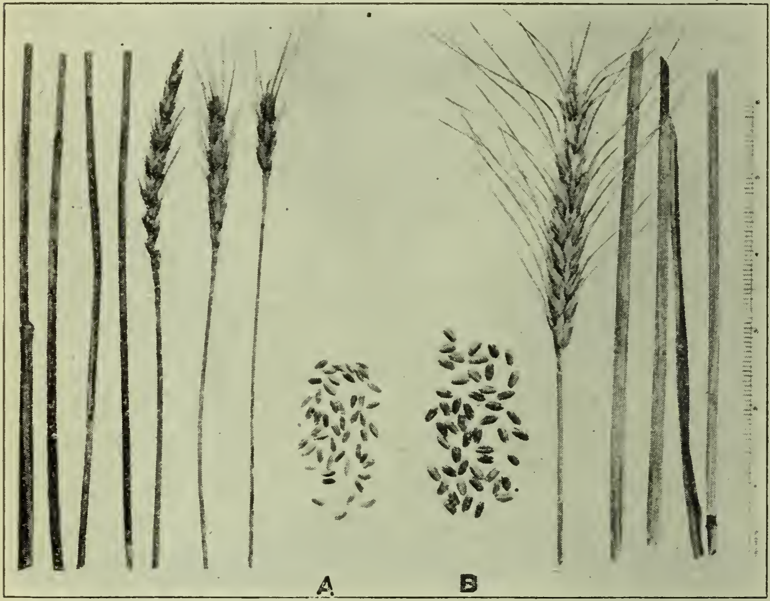


FIG. 3.—THE STEM RUST CAUSES SMALL HEADS AND BADLY SHRIVELED GRAIN

The wheat heads shown at A were collected near a barberry bush where the rust was very heavy. The heads are small, the straw is poor, and the grain is light and shriveled. The head shown at B was from a portion of the field free from rust. The heads are large, the straw is clean, and the grain plump and heavy.

HEAVY DAMAGE DONE BY VARIOUS RUSTS

The annual losses from stem rust attacks on grains are enormous. Briefly, the disease affects the crop as follows: The stem rust actually splits the stems of the growing grain plants, which breaks the outer layers and allows a large amount of water to escape. Experiments have shown that wheat plants badly rusted with stem rust require about one-third more water than similar non-rusted plants. Besides this loss of water, the fungus causing the rust feeds on the stem of the growing plant just below the head and robs the plant of the food which should normally go to the head to form plump heavy kernels. Thus, as is well known, the grain from badly rusted plants becomes greatly shrunken (fig. 3). The leaf rusts, on the other hand, do not cause nearly so severe injuries. They split the leaves and sheaths but very little or not at all and, therefore, do not cause a large loss of water. They do not occur on the stem to any extent and, therefore, do not rob the plant of the food

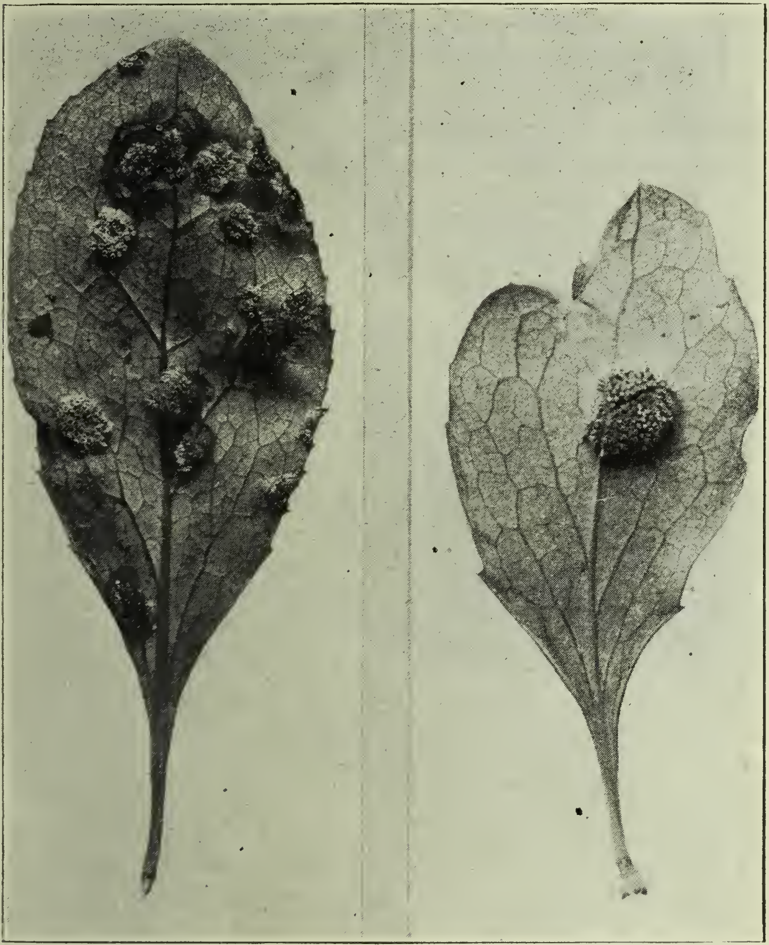


FIG. 4.—THE STEM RUST FORMS CLUSTER CUPS ON THE LEAVES OF THE COMMON BARBERRY

The cluster cups of the spring stage of stem rust appear on the under surface of the common barberry leaves and spread spores to the surrounding grains and grasses. The large cluster cup on the right is magnified in fig. 6.

which is in the stem ready to be sent to the filling head. The slight loss caused by the leaf rusts is due to a small loss of water by the plant and small losses of food. Experiments and observations have shown that the losses caused by the leaf rusts are, in general, far less than those caused by the stem rust.

Relation of Barberry to Stem Rust in Wisconsin

The common barberry is universally rusted in Wisconsin. The first appearance of the rust on the barberry is generally about the first of May and spore production continues until the latter part of June. A few barberry leaves carrying a normal rust infection are shown in figure 4. The single cluster cup, or so-called aecium, (fig. 5) contains enough rust spores to sow rust over a 40-acre grain field.

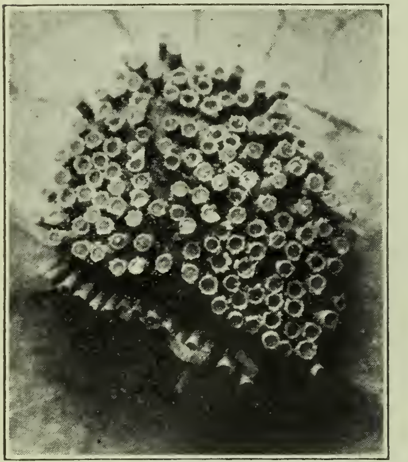


FIG. 5.—CLUSTER CUP OF THE STEM RUST ON BARBERRY HIGHLY MAGNIFIED

Each little cup contains spores enough to sow stem rust on an acre of grain. There are spores enough on the whole cluster cup to spread rust over a 40-acre field.

Extensive field observations and field tests have been made in Wisconsin during the last two years to learn if the barberry is an important factor in starting stem rust infections in the spring. During the fall, regions were located where the rust was abundant. Definitely marked locations on grasses were carefully observed throughout the winter and following spring. Careful search at these stations gave no evidence of new stem rust infections previous to the time when such infection could have come from rusted barberries.

Further careful observations on the winter stage of the rust on grasses and grains showed that about 18 days after the winter spores began to germinate in the field, rust infections appeared on the barberry. After the barberries showed the rust, the rust infections were first noted uniformly on the grains and grasses near infected barberries.

Numerous cases were observed to note the spread of the rust from infected barberries to grains and grasses. In one of these cases, there was a hedge of barberries heavily infected with rust near a quack grass meadow. In this meadow early in the season the rust was very abundant on the quack grass near the barberries and became less and less abundant away from the barberries. Careful counts were made of the actual proportion of rusted and non-rusted grass stems at various locations and distances from the infected barberries. The results are given in Table I and in the figure on the cover.

TABLE I.—SPREAD OF STEM RUST TO QUACK GRASS FROM RUSTED BARBERRY HEDGE

Station number	Direction from barberry	Distance from barberry	Per cent of grass stems infected
1	NE	15 feet	100
2	NE	40 "	95
3	NE	65 "	80
4	NE	90 "	30
5	NE	125 "	41
6	NE	150 "	15
7	NE	175 "	10
8	NE	200 "	10
9	NE	225 "	5
10	NE	250 "	2
11	NE	275 "	2
12	NE	300 "	1
13	NE	325 "	1
14	NE	350 "	0.5
15	NE	375 "	1
16	NE	400 "	0.5
17	NE	425 "	0.5

It was strikingly evident, as shown in Table I and the figure on the cover, that the rust spreads from the barberry.

Similar observations were also made in grain fields near barberries with similar results in all cases.

Observations and results have been made repeatedly in other states and in other countries, showing that there is undoubtedly a direct relation between the rust infections on the barberry in the spring and the spread of the rust to grains and grasses. The observations in this state show that this is particularly true in Wisconsin. Hence, the barberry should be eradicated.

Three Different Kinds of Barberry Common in Wisconsin

There are a large number of different barberries described and grown, but only three species have been commonly planted in Wisconsin. The common or tall European barberry *(Berberis vulgaris)* with green leaves, and the variety with purple leaves *(purpurea)* have been planted quite commonly not only in cities and villages, but also on many of the Wisconsin farms. This species has escaped from cultivation in at least nine different places in the state. The common barberry helps to

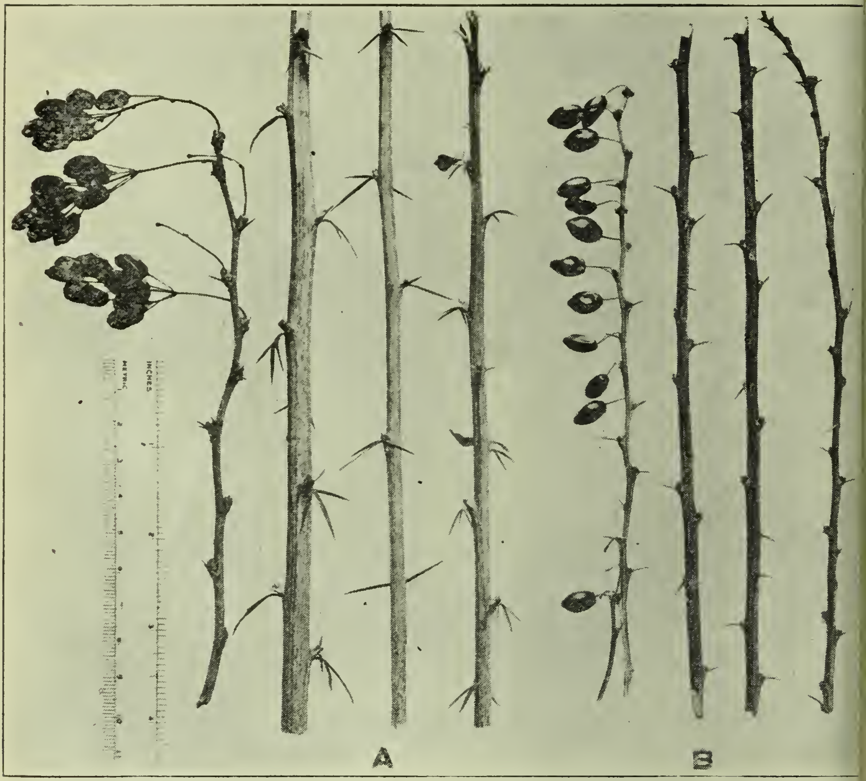


FIG. 6—COMMON AND JAPANESE BARBERRY ARE DIFFERENT

The common or tall barberry (fig. A) has coarse, grey stems, usually three-parted spines, and the berries in long drooping bunches like currants. The Japanese barberry (fig. B) has brown slender stems, usually single spines, and plump berries singly or in small and short clusters of two, like gooseberries.

spread stem rust and, therefore, is dangerous. The Mahonias, chiefly *Mahonia aquifolium,* have been planted in a few locations. Certain of the Mahonias harbor the stem rust and are, therefore, harmful. Finally, the Japanese barberry *(Berberis Thunbergii)* has been used in nearly all of the parks and many of the residence grounds in the state. The Japanese barberry does not carry the stem rust and, therefore, is harmless.

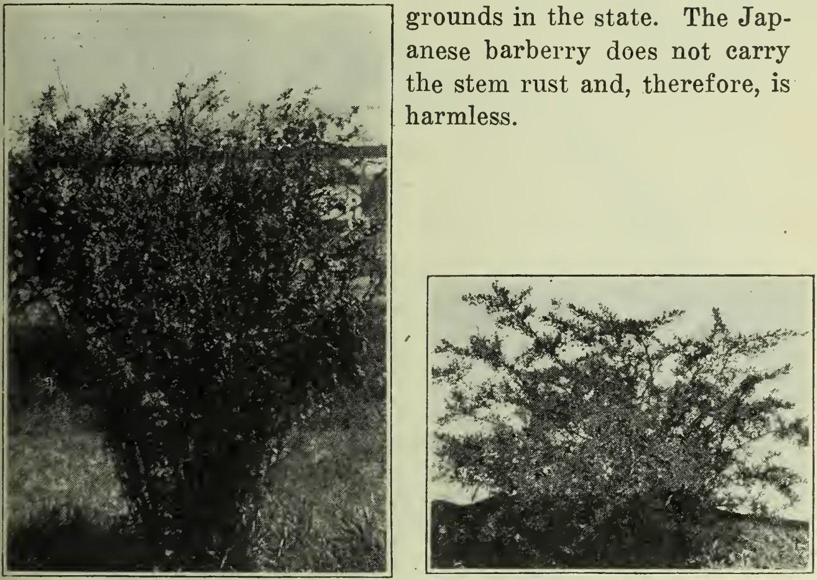


FIG. 7.

THE DANGEROUS BARBERRY THE HARMLESS BARBERRY

The tall barberry (left) helps to spread stem rust, is dangerous and should be destroyed. The low Japanese barberry (right) is harmless and may be grown.

The Harmful Common or European Barberry

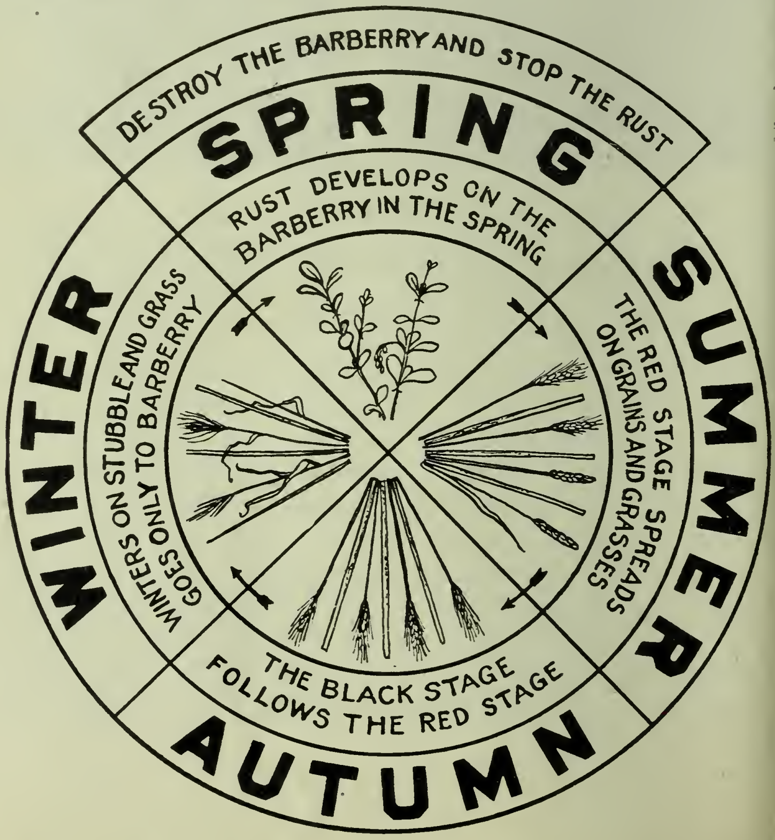
The common or tall European barberry varies greatly, yet it is readily recognized. It is a rather tall, upright or slightly arching, spiny shrub, with gray branches which have four grooves running the entire length of each branch (fig. 7.) The spines are usually three-parted at each leaf bud (fig. 6 A). Occasionally, however, simple spines occur. Several other species of plants have three-parted spines, as, for example, the wild gooseberry, but these plants, instead of being smooth-stemmed as the barberry is, have a mass of small hairs covering the surface of the stem. The oblong red berries hang in long clusters and are shriveled and wrinkled in the winter and spring (fig. 6 A and figure in Table II). The leaves have toothed margins. (See figure in Table II). The purple-leaved, common, or tall, European barberry is identical with the green-leaved form except in the color of the leaves.

THE MAHONIA

The Mahonias are not very common in Wisconsin, as they winter-kill badly. They are low shrubs with spineless branches and compound coarsely and sharply toothed leaves. The round blue berries hang in long clusters.

THE HARMLESS JAPANESE BARBERRY

The Japanese barberry is a rather low, somewhat spreading, dense-growing, spiny shrub (fig. 7) with reddish brown branches. The spines are rather small and usually simple, but with occasional small side spines (fig. 6). The plump, oval, scarlet berries hang singly or in pairs (fig. 6 B and figure in Table II). The leaves are rather small with entire margins. (See figure in Table II.)


DESTROY THE BARBERRY AND STOP THE RUST
SPRING
RUST DEVELOPS ON THE BARBERRY IN THE SPRING
SUMMER
THE RED STAGE SPREADS ON GRAINS AND GRASSES
AUTUMN
THE BLACK STAGE FOLLOWS THE RED STAGE
WINTER
WINTERS ON STUBBLE AND GRASS GOES ONLY TO BARBERRY

75b

Bulletin 305 September, 1919

Wheat Growing in Wisconsin

E. J. DELWICHE and B. D. LEITH

THE WISCONSIN WHEAT HARVEST

Wheat is a profitable crop to grow in many parts of the state. High-yielding pedigreed seed is available for sowing, and the soil and climate combine to make heavy crops possible.

AGRICULTURAL EXPERIMENT STATION
OF THE UNIVERSITY OF WISCONSIN

MADISON

DIGEST

Certain parts of Wisconsin are well adapted to the profitable production of wheat. The crop is not unusually hard on the soil where crop rotations are practiced. Pages 3 to 4.

Some wheats are better suited to Wisconsin conditions than others. Descriptions are given of the Turkey Red, Marquis, Fife, Bearded Spring, Prelude, Blue Stem, and Durum or Macaroni varieties. Some of these are more resistant to disease, others yield more heavily, and still others have superior baking qualities. Pages 4 to 5.

Pedigree varieties of high producing wheats are now available for the Wisconsin wheat grower. It pays to grow the best. Pages 6 to 7.

Winter wheat is best for Wisconsin. It has a number of advantages over spring wheat when climate, soil, and other conditions are considered. Pages 7 to 8.

Early plowing makes the best seed bed for winter wheat. Sow late in August or early in September, depending on the season and the part of the state. Drilled wheat yields best. The rate of seeding varies with the season but from six to eight pecks is usually sown. Pages 8 to 11.

Stacking the grain improves the quality. It also prevents any serious damage from weathering. Pages 11 to 12.

Winterkilling is resisted by some varieties better than others. Early seeding and a good seed bed help to prevent losses. Pages 12 to 14.

Crop rotations are needed if the largest possible yields are to be secured and the soil kept at its best. The rotation varies in different localities, depending on the soil and climatic conditions. Pages 14 to 16.

Experiments have determined the best varieties for Wisconsin. Hundreds of strains have been tested, the poorest discarded, and the promising ones developed into the high yielding pedigree strains now recommended. Page 16.

Wheat Growing in Wisconsin

Wisconsin has "come back" as a wheat-producing state. In 1917 and 1918, Wisconsin doubled her wheat acreage and found that profitable returns were possible on many soil types.

On the right kind of soil, in the proper rotation, and with high-yielding, pedigreed seed, wheat is now a prominent and paying crop in the state.

Regions Where Wheat Grows Best

When grown in a rotation wheat does well on heavy loams and clays, but it does not do so well on light soils. The red clay districts south of Lake Superior in Douglas, Bayfield, Ashland, and Iron counties are adapted both to winter and spring wheats.

Around Lake Winnebago and along the Lake Michigan shore, besides the territory near the Fox river, are found other sections where wheat thrives. Parts of Barron, Polk, and St. Croix counties in the western part of the state have soils adapted to wheat. All of the southern part of the state, including the first two tiers of counties, is adapted to wheat raising.

Winter wheat is grown on the well-drained loams of southern Wisconsin, while on the red clay soils wheat does better than barley. This condition is due, perhaps, to the well-developed root system of the wheat plant which enables it to grow under more adverse conditions than barley.

Wheat Is Not Unusually Hard on the Soil

Wheat is not harder on the soil than oats or barley as has often been claimed. Judging by the amounts of plant food removed for equal amounts of dry matter in the grain, this cannot be the case. In Table I are shown the amounts of plant food removed by 1,000 pounds each of wheat, oats, barley, and rye.

When the average prices for the 10 years (1904–1914) are taken as a standard, wheat removes about one-sixth less fertility per dollar's worth of grain than oats does, and an eighth less than barley or rye. These facts are shown in Table I.

TABLE 1.—COMPARISON OF MARKET VALUES OF DIFFERENT GRAINS WITH THE VALUE OF THEIR FERTILIZER CONSTITUENGS

		BARLEY	OATS	RYE	WHEAT
Fertilizer constituents per 1,000 lbs.	Nitrogen	19.2 lbs.	18.2 lbs.	18.1 lbs.	19 lbs.
	Phosphoric acid	7.9 "	7.8 "	3.6 "	8.7 "
	Potash	4.8 "	4.6 "	5.8 "	5.5 "
Value of fertilizer per 1,000 lbs.		3.515	3.36	3.415	3.56
Average price per bu. 1905-1914		$0.62	$0.88	$0.69	$0.79
Value of 1,000 lbs. of grain		$12.92	$10.60	$12.32	$13.16
Value of fertilizer constituents expressed in percentage of value of grain		27 2/10%	28 1/4%	27 7/10%	24 1/4%
Value of fertilizer for each $1 of grain sold		$0.27 1/5	$0.28 1/4	$0.27 7/10	$0.24 1/4

(Prices are for 1905-1914 inclusive.)

If grain growing is to be permanently profitable, it is necessary to keep up the fertility of the soil. In order to grow the largest possible crops of wheat there must be kept an abundant supply of plant food in the soil. Organic matter is necessary to secure the proper physical conditions of the soil. Heavy soils deficient in vegetable matter are hard to work and in dry seasons they suffer from a loss in moisture. Most of the new clay lands in upper Wisconsin are low in nitrogen, but clover in the rotation will supply this needed element. Stable manure may be used for the same purpose. A light dressing of manure may be applied to the preceding cultivated crop or applied directly to the wheat as a topdressing.

DESCRIPTION OF SOME COMMON WHEATS

Turkey Red. This is a bearded, white chaff wheat with a rather short, nearly square tapering spike. The kernels are held rather tightly in the chaff, making it a little harder to thresh than the average wheat. The berry is quite large, varying in color from dark amber to yellow. As a rule, the Turkey Red wheats are good bread wheats, but some strains show considerable superiority to others.

The Pedigree No. 2 and the Bacska Pedigree No. 408 belong to this group. The No. 408 has a slightly larger spike and berry. These are very good bread wheats.

Marquis. This is a beardless, white chaff wheat. The kernels are very short and chunky with very wide crease, and dark amber color.

Fife. The Fife resembles the Marquis very closely, but the berry is not quite so short and chunky. The milling and baking quality of these wheats is unsurpassed.

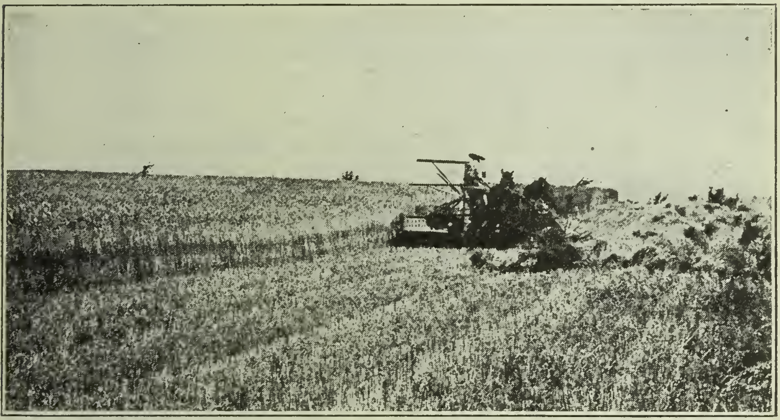


FIG. 1.—MARQUIS IS THE BEST WISCONSIN SPRING WHEAT

This field, yielding 36 bushels to the acre, shows the superiority of Marquis wheat in trials at the Madison station.

Bearded Spring. In the spring wheat district, these wheats are usually called Velvet Chaff. They have bearded, smooth, white chaff. The berry has a full crease and is somewhat tapering. There is a dark-kerneled and a lighter-kerneled type. As a rule, these wheats are good yielders but are not ranked so high in milling and baking qualities as Marquis and Fife. Some of the names commonly applied to members of this group of wheats are Early Java, Preston, Bearded Fife, and Blue Ribbon.

Prelude. This is a bearded spring wheat of entirely different type than the Velvet Chaff group. It is a short-strawed, and stools very little. It matures very early, ripening about the time of winter wheat. The head is short and light brown in color. The berry is short, chunky, rounding and often soft.

Tests show rather low yields and inferior milling and baking quality.

Blue Stem. This variety is beardless and has downy or hairy chaff. Under Wisconsin conditions it has not proved as satisfactory as Fife and Marquis, and in most sections of the state it is more susceptible to disease.

Durum or Macaroni. This wheat is suited to dry regions and does not give best results in most sections of Wisconsin as a general rule. It is bearded and has a very large square spike. The kernel is very large, amber-colored and glassy. In the dry areas it is very resistant to rust but in the Wisconsin climate it becomes somewhat more susceptible to this disease and the berry has a tendency to become white and chalky.

PAYS TO GROW PEDIGREED WHEAT

The farmer cannot afford to buy new and untried varieties. Experiments have shown conclusively that some varieties which have proved good yielders of high quality in regions where they are well adapted, have failed when grown under a new environment. Certain varieties well adapted to adjoining states have failed when tested in Wisconsin.

It is the work of the Wisconsin Experiment Station to test different varieties and find which ones are best suited for conditions in the state. The tests must be carried on through several years to learn which varieties will do well in unfavorable as well as favorable years. By testing a large number over a series of years, those which show the highest average performance can be determined and the undesirables discarded.

The work does not stop with tests of varieties, but the most promising individual plants are selected from these varieties and new pure lines are started. Comparisons of these often bring out an individual strain which is better suited to the new conditions than the parent stock and such a new line then stands out as a pedigree strain of superior quality.

The desirable characteristics in wheat are hardiness, high yield and good bread-making quality. A high-yielding wheat often lacks hardiness and some very hardy wheats are low yielders. If an individual having one of these characters is crossed with one of the other type there is a possibility that some plants in the progeny will have a combination of both hardiness and high-yielding power. Isolation of these desirable strains cannot be accomplished in a single season but takes years of painstaking effort on the part of the plant breeder.

GOOD SEED ESSENTIAL

As experiments have shown quite conclusively that the best yields of wheat are obtained by sowing plump rather than small and immature seed, only grain which is plump and uniform in size should be sown. The grain should be carefully cleaned with a good fanning mill to rid it of shrunken and immature seed, weeds and other impurities. One-year old winter wheat seed is preferable to freshly threshed seed, as the newly threshed grain does not germinate as readily as that from the previous season. Experiments have shown that a resting stage of about two weeks is necessary to secure perfect germination. An added reason for this suggestion is that it is often impossible to get the crop threshed early enough to sow at the proper time.

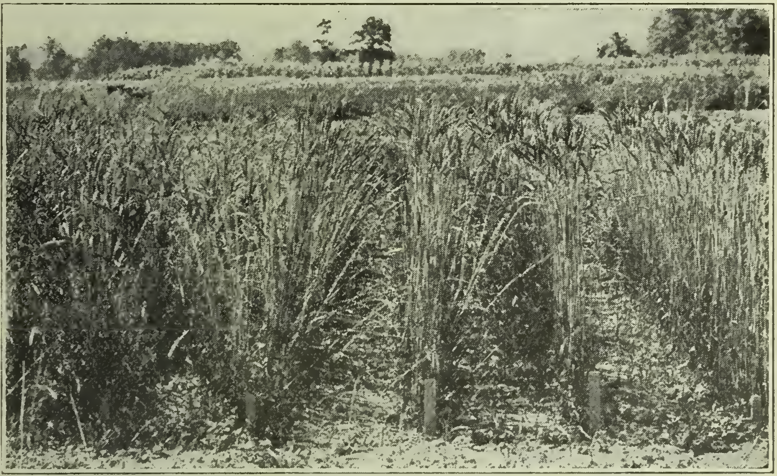


FIG. 2.—STRENGTH OF STRAW VARIES IN THE SAME STRAIN

These breeding rows emphasize the importance of obtaining tested seed. With the same chance of standing, certain lines show greater weakness than others and are discarded.

Many farmers believe that after a few years wheat "runs out" and that from time to time the seed should be changed. This idea is wrong. With proper care in grading and cleaning, so as to keep the seed pure, a variety adapted to the climate and soil conditions will not deteriorate.

ADVANTAGES OF WINTER WHEAT

Winter wheat outyields spring wheat in Wisconsin. At Madison winter wheat outyielded spring wheat on an average, 13 bushels to the acre; at Ashland, 8.2 bushels; and at Marshfield 4.3 bushels.

Winter wheat is able to use plant food in the soil more efficiently than spring wheat. The fall grown crops make use of the plant foods which otherwise are leached out by autumn rains and would be lost.

Winter wheat excels as a nurse crop. It is harvested earlier than spring sown grain and thus gives the clover crop a better chance to compete for food and moisture.

Winter wheat does not rust as does spring wheat. The rust seldom attacks winter wheat while on the other hand spring wheat is often damaged by it.

The seeding of winter wheat comes in the fall while the seeding of spring wheat comes at the time of the rush of spring work. Where help is hard to get this is a factor decidedly in favor of winter wheat.

Winterkilling is the chief disadvantage of the winter wheat. When partly winterkilled the wheat stools so profusely that it usually pays to let the crop stand. When winter wheat is completely winterkilled early oats may be sown to get a crop from the field. When rust attacks spring wheat there is no way of getting a crop.

PREPARING THE SOIL FOR WHEAT

Land intended for winter wheat should be plowed in July or August rather than in September. The soil should be given time to settle between plowing and seeding.

Wheat requires a firm, well-compacted seed bed. This allows the seed to come in close contact with the soil particles and enables the roots to feed readily upon the available plant food. A heavy rain after plowing will generally compact the soil sufficiently. If the weather is dry it will be necessary to compact the soil with a roller or other implement, particularly if a large amount of vegetation has been turned under. Green vegetable matter plowed under, unless compacted immediately after plowing, causes the soil to dry out excessively. The harrow should always follow the roller to form a mulch, thus preventing the loss of moisture which is brought to the surface by the compacting of the soil.

It is also necessary for the surface of the seed bed to be loose and crumbly. This prevents the moisture from evaporating. Upon heavy soils this condition is most easily secured by disking immediately after plowing. In some sections the same results may be obtained by harrowing. Some conditions arise where it is necessary to disk twice and harrow. On heavy soils care should be taken not to pulverize too much, for if heavy rains should follow shortly after the grain is sown there would be danger that a crust would be formed, which would prevent the grain from coming up well and making a thrifty growth.

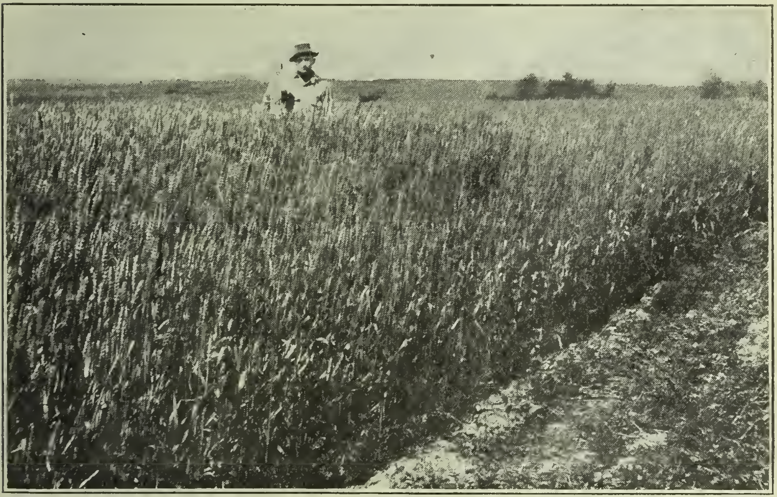


FIG. 3.—WHEAT THRIVES IN UPPER WISCONSIN

The heavy soil areas of the northern counties are well adapted to growing both winter and spring wheats.

Rather small lumps ranging in size from that of walnut to that of a man's fist and a little larger are no objection on a winter wheat field, as the action of frost tends to pulverize the lumps, leaving the ground in good condition in spring. These lumps also tend to hold the coating of snow over the field, preventing the freezing and thawing of the soil, which is one of the causes of winterkilling.

All lands intended for spring wheat should be fall plowed. This rule applies to the management of rather light and loamy soils as well as heavy clays. The lighter soils should be fall plowed in order to give the land time to settle and become firm. Heavy soils need the effect of winter freezing to pulverize them and improve their tilth. Another very good reason for fall plowing is that wheat should be sown as early as possible in spring.

THE BEST TIME TO SEED

In the northern section of the state, winter wheat may be sown from August 25 to September 10. In the southern part of the state it is sown between September 10 and 20, varying somewhat with the season. Enough growth should be made so that the leafage may serve as a mulch for the roots, thus preventing early thawing. Besides, if the root development is strong there is less danger of heaving and consequent winterkilling.

Spring wheat should be sown just as early as the season permits. As a rule, there is less danger of ''puddling'' heavy soils early in the season than later, when heavy rains have partly destroyed the mellowness caused by frost action. The best rule is to sow wheat as soon as the ground is dry enough to work well. Some of the best wheat ever grown in the Lake Superior region was sown the latter part of March. If conditions permit getting on the land before the soil has been settled by the action of spring rains, much less work is needed to put the ground in shape for seeding than is required later in the season. Working the ground twice with the disk, spring tooth harrow, or cultivator, and following with a smoothing harrow is usually sufficient to put the seed bed in good condition.

DRILLED WHEAT BEST

The drill is preferred to the broadcast seeder for several reasons. In the first place less seed is needed to obtain a good stand, and in the second place the drill puts the seed at a more uniform depth, insuring greater uniformity in germination. Broadcasted winter wheat suffers more from winterkilling than drilled wheat.

The depth of seeding will vary with soil conditions. The rule should be to place the seed deep enough to come in contact with moist soil. This is usually from one to three inches. In wet seasons on heavy clays care should be used not to sow spring wheat too deep.

TIME OF SEEDING DETERMINES RATE

Several factors influence the rate at which grain should be sown. Among these are the kind of soil and its condition with respect to fertility, time of seeding, the size of the kernel and the stooling habit of the variety. As a rule less seed is needed on rich soil to secure the same thickness of stand as on poor soil. Grain usually stools out better on good than on poor land. Less grain is usually needed on heavy than on light soils.

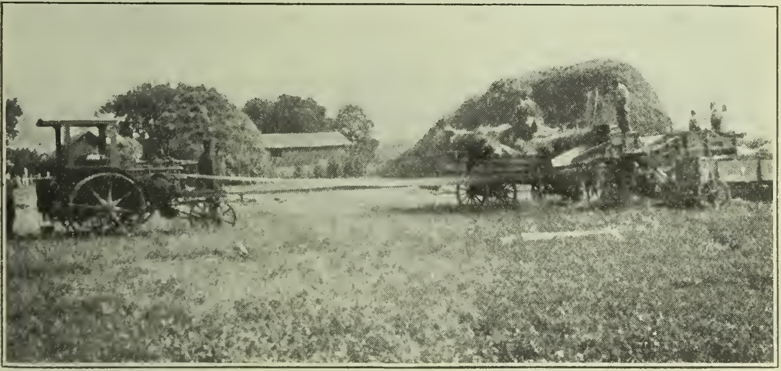


FIG. 4.—THRESHING WINTER WHEAT FROM THE SHOCK

Although threshing from the stack is preferable with all small grains, winter wheat must be threshed from the shock to have the seed available for planting the same fall.

The rate is also largely determined by the time of seeding. Winter wheat sown late in August or early in September in upper and central Wisconsin and about the middle of September in the central and southern portions of the state will have ample time to stool out if a sufficient amount of moisture is present in the soil, and as a consequence less seed is needed than if sown three or four weeks later.

The size of kernels must also be considered in determining the rate at which to sow wheat. To obtain the same stand the gauge should be opened wider when sowing the larger- than when sowing the smaller-kerneled varieties. For example, experiments have shown that Durum wheat, a large-kerneled and poor-stooling variety, requires approximately one-half bushel more seed to the acre than do the Fife and Marquis types. If, for any reason, it is necessary to sow seed which is shrunken, badly discolored, or somewhat damaged and immature, considerably more must be sown because of its size, condition, or low vitality. In this connection it should be added that all seed should be tested to determine its germinating power. The amount of seed of good quality to sow will vary from six to eight pecks an acre for both winter and spring varieties.

THRESH FROM STACK, NOT SHOCK

In order to secure bright, sound, high-grade wheat it is necessary to harvest the crop as soon as it is ripe. It is a good plan to cover the shocks with bundles as a protection against rains. Some kinds of wheat, such as the Marquis and Fife and the hard winter varieties, thresh with difficulty if cut when under-ripe. On the other hand, if allowed to stand too long after ripening, the berry becomes bleached and discolored.

Threshing wheat from the shock is not to be recommended. Much loss, particularly during wet seasons, results from this practice. As soon as the grain is dry, it should be stacked, or, better still, stored in barn or shed. When wheat is allowed to sweat in the stack or barn for five or six weeks, its color and quality is very much improved. If threshing must be done shortly after stacking, the grain should be spread out thinly upon the barn or granary floor to prevent heating.

> TO insure against winterkilling obtain hardy varieties; plant early; sow at a heavier rate if seeding is delayed; work up a good seed bed; have the field in a good state of fertility.

SOME WHEATS RESIST WINTERKILLING BETTER THAN OTHERS

The winter of 1917–1918 was especially severe and gave an excellent study of winter hardiness on the Madison station plots. The fall was so cold that even though the plots were sown in ample time the growth was very small at the time the ground froze. In many cases high yielders proved non-resistant to winterkilling. But fortunately, Pedigree No. 2 was among the few that survived, though not without some loss.

Observations show that winterkilling has been most severe on fields where the plants had a small growth in the fall. This occurred on fields poorly prepared or low in fertility.

If the winter wheat stand is thin in the spring do not plow it up and sow another crop at once but allow it to stand until all the other small grains are planted and by that time a better estimate of the growth can be made. Winter wheat will stool very profusely when thin, and even through the plants may appear scattering, fair yields may result.

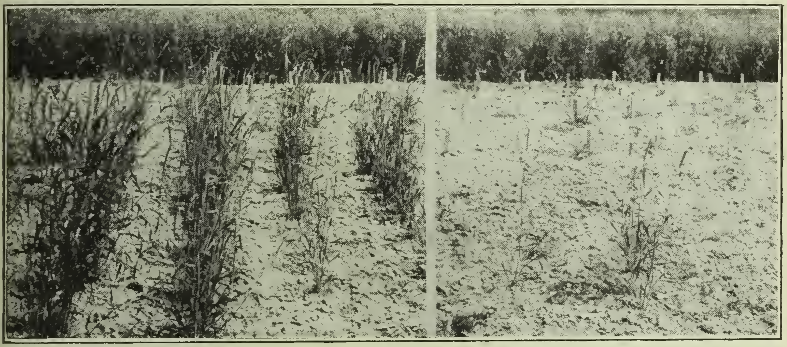


FIG. 5.—PEDIGREE NO. 2 SURVIVED THE WINTER OF 1917-18

Hardier strains are being developed from the plants of Pedigree No. 2 wheat (left) which survived the severe weather early in 1918. Contrast these rows with the winter-killed rows of other varieties as shown by the stakes at the right.

As a further protection against winterkilling a light top dressing of straw or strawy manure is found very beneficial. Care must be taken not to leave the manure in bunches as it may smother the wheat under it.

TROUBLESOME DISEASES OF WHEAT

Rust, smut, and scab are the three diseases which cause the most loss in wheat fields. Stem rust is named from the rust colored spots on the stem and leaves. The spots turn black about harvest time. No treatment of the seed is recommended, as a solution strong enough to kill the rust also kills the wheat.

Two kinds of smut infect wheat. The loose smut, which is not very troublesome, affects the whole head, and leaves bare the stalk to which the flowers are attached.

Covered smut is a serious pest. The disease is not easily recognized in the field, as the chaff is not attacked. The kernels, however, become a mass of smut spores and a brownish rounded ball of smut takes the place of the berry. The disagreeable fishy odor gives the disease the name of "stinking smut." The mass is broken at threshing time and the smut spores lodge on the wheat kernels, ready to grow when the grain is planted.

This disease is controlled by the formalin treatment, as is oat smut. The solution is made as follows: 1 pint of formaldehyde (40 per cent) in 30 gallons of water, temperature about 60°F. Dip the seed, in loosely filled burlap or gunny sacks, into the solution and soak for five minutes. Drain and spread the grain on a clean floor or canvas and cover with sacks or canvas for two hours. Stir occasionally with rake or shovel to hasten drying. Sow as soon as the seed will run freely, or dry thoroughly and store in clean bags or bins until seeding time.

Scab is one of the diseases recently discovered. The head, or part of it, sometimes only a single flower, turns white, and as the plant approaches maturity a pinkish color shows on the chaff or the stalk of the head. This disease has caused great loss in some wheat fields. No method of controlling it has been found.

ROTATIONS FOR WHEAT

Wheat should be grown in rotation with other crops, only. This is true of all cereals, if not all crops.

A standard four-year rotation is clover, mixed hay, cultivated crops, wheat. Manure is applied to the sod before corn. This rotation is a good one for the production of spring wheat, but it is not suitable for winter wheat, except where the corn or other cultivated crop can be removed very early. Limited tests indicate the possiblity of sowing wheat in the corn at the last cultivation. This method has been very successful with rye, and it is regularly followed at the Ellis Junction substation.

This rotation may be made into a five-year rotation by sowing timothy with the clover and running hay two years instead of one.

A good rotation useful for farms devoted largely to grain production is: corn, oats or barley seeded to clover; winter wheat seeded to clover; clover (manured). In this rotation one of the clover fields may be used for pasture. The two clover crops help to maintain the nitrogen supply.

An excellent rotation for winter wheat is clover, cultivated crop, peas (field or canning), and winter wheat seeded to clover. The land is disked immediately after the peas have been removed, and the wheat is sown late in August or early in September. This rotation has given the best results of any tried at the branch experiment station at Ashland Junction. It saves labor, since no plowing is required for the wheat, and it provides a firm seed bed.

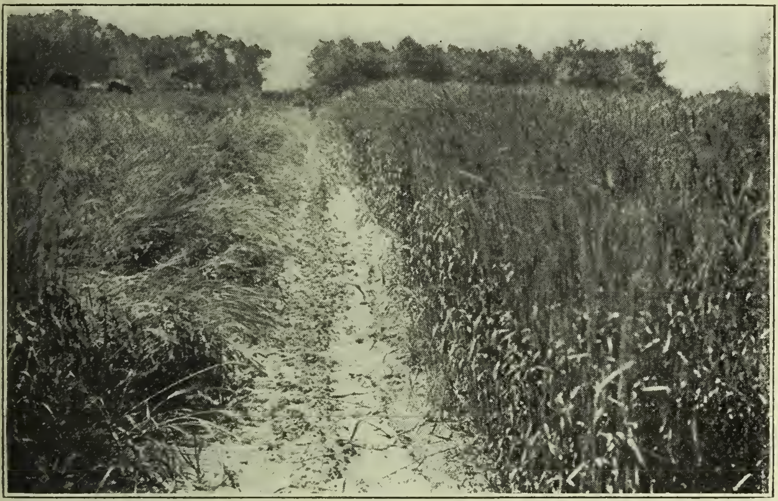


FIG. 6.—WHICH VARIETY WOULD YOU CHOOSE?

The loss from lodging grain may be as high as 50 per cent. Great differences in the stiffness of straw are found in different varieties.

Winter wheat may properly be the first crop on new land. providing the land is broken in midsummer so as to allow time for the soil to settle well. Spring wheat may also be sown on new breaking, but only when the plowing is done in the fall.

On rich soils where there is difficulty with small grains lodging, the first rotation suggested may be used, with the exception that corn should follow corn or small grain should follow small grain. In the latter case the winter wheat could follow an oat or barley crop, thus affording ample time to plow the stubble and get the wheat in the ground.

When it is desired to sow winter wheat on sod land, the sod should be well plowed, a jointer being used to turn down all grass. The plowing should be done early, no later than August 15. The ground should be well rolled, then disked. This will aid in the rotting of the sod by preventing the growth of grass between furrows, and it will allow for the absorption of rainfall. When seeding time comes the land should be thoroughly packed with the roller so as to provide a firm seed bed.

VARIETY TESTS DETERMINE BEST WINTER AND SPRING WHEATS

Tests to determine the best varieties of wheat adapted for different sections of Wisconsin have been in progress at the experiment station at Madison and at the branch stations at Ashland and Marshfield since 1906.

One hundred thirty-six varieties and strains of spring and winter wheat have been tested and most of them have been discarded. Only those that showed promise were continued for a longer period than five years. The yields tabulated report only on the most promising varieties, beginning with the year 1914.

Of the winter wheat varieties those of outstanding importance are the Ped. No. 2—Turkey Red and Ped. No. 408—Bacska. Other varieties have shown very good promise so far as yield is concerned, but these two are not only high yielders but are also the two best wheats from the milling and baking standpoint.

Of the spring varieties the Red Fife and Marquis show the best yields. It will be noted, however, that the Marquis is outstandingly the best variety at Madison while the Red Fife gave the highest average yield at Ashland. The yields at Marshfield are rather inconclusive,—Marquis, Red Fife and Early Java are about on a par. Taking into consideration yield, quality and availability of seed the following recommendations are made:

For southern Wisconsin, Pedigree No. 2—Turkey Red for a winter variety and Wisconsin No. 50—Marquis for spring.

For the northern section of the state, Pedigree No. 2 and Pedigree No. 408 are recommended for winter varieties and Red Fife and Marquis for spring.

TABLE II—SPRING WHEAT VARIETY TESTS—MADISON

Variety	1914	1915	1916	1917	1918	No. of years	Average
Marquis, Wis., No. 50	15.2	35.0	20.3	17.7	30.5	5	23.7
Fife. Minn., No. 163	10.0	23.0	16.7	8.4	28.4	5	17.3
Blue Stem, Wis.. No. 30	11.5	24.0	14.7	8.0	27.2	5	17.1
Blue Stem, Ped., No. 36	....	24.0	12.0	7.4	25.1	4	13.7
Prelude, Wis., No. 49	....	40.0	12.1	15.4	19.3	4	17.4
Bearded Red Fife, Wis., No. 60	....	23.0	15.1	8.4	27.7	4	16.8
Red Fife, Wis., No. 46	....	23.6	13.6	6.4	19.8	4	12.7
Ped. 9171	....	....	17.4	8.4	26.8	3	14.9

TABLE III—WINTER WHEAT VARIETY TESTS—MADISON

Variety	1914	1915	1916	1917	1918	No. of years	Average
Turkey Red, Ped. No. 2	40.7	37.6	45.8	51.4	17.7*	5	38.6
Turkey Red, Kan. No. 570	43.2	48.4	27.4	49.0	W. K.	5	33.6
Egyptian Amber, Wis. No. 37	50.0	39.0	25.5	51.4	W. K.	5	33.2
Kharkov., Ped. No. 609,	39.0	33.0	29.0	40.4	19.3	5	32.1
Red Wave, Wis. No. 54	....	55.3	27.3	57.0	W. K.	4	34.9
Nixon, Wis., No. 59	....	54.6	30.4	51.7	W. K.	4	34.2
Turkey Red, Ped. No. 14	....	42.5	28.5	49.7	12.5	4	33.3
Farmer's Friend, Wis. No. 55	....	56.6	27.8	48.3	W. K.	4	33.2
Orange, Wis., No. 56	....	44.0	35.0	51.0	W. K.	4	32.5
New Genessee, Wis. No. 61	....	45.3	24.6	52.7	W. K.	4	30.6
Gluten Berry, Wis. No. 53	....	40.0	32.4	47.0	W. K.	4	29.8
Turkey Red, Wis. No. 45	....	....	30.5	52.0	11.7	3	31.4
Beloglina, Wis. No. 71	....	....	30.0	43.0	14.0	3	29.0
Early Russian, Wis. No. 51	....	....	37.0	44.3	W. K.	3	27.1
Mich. Amber, Wis. No. 73	....	....	32.7	44.9	W. K.	3	25.9
Budapest, Wis. No. 72	....	....	34.3	42.5	W. K.	3	25.6
Dawson's Golden Chaff, Ped. No. 39	....	....	27.0	49.5	W. K.	3	25.5
Beloglina. Wis. No. 70	....	....	29.0	37.7	5.7	3	24.1
Ped. No. 38	....	....	27.7	44.0	W. K.	3	23.9

* Winterkilled.

TABLE IV.—SPRING WHEAT VARIETY TESTS—ASHLAND BRANCH STATION

Variety	1914*	1915	1916	1917	1918	Average 4 yrs.	Average 5 yrs.
9171 Red Fife	....	25.9	18.2	23.8	17.1	21.3	17.0
10253 Red Fife	....	33.0	18.5	20.0	11.8	20.8	16.7
Minn. No. 169	....	33.9	15.5	18.0	10.2	19.4	15.5
Marquis	....	33.8	15.5	18.0	8.8	19.0	15.2
9199 Blue Stem	....	28.3	14.4	15.7	12.8	17.8	14.2
Common Blue Stem	....	29.0	13.3	17.6	8.7	17.2	13.7
9186 Red Fife	....	25.4	12.0	16.8	14.0	17.0	13.6
10294 Blue Stem	....	25.0	11.3	18.0	12.1	16.6	13.3
Early Java	....	26.9	11.2	16.6	9.8	16.1	12.9
9194 Blue Stem	....	25.6	13.9	14.8	9.1	13.4	10.7

* No yield due to rust.

TABLE V.—WINTER WHEAT VARIETY TESTS—ASHLAND BRANCH STATION

Variety	1914	1915	1916	1917	1918	No. of years	Average
Ped. 408 Bacska	17.7	(None Sown)	51.0	35.2	15.8	4	29.9
Mich. No. 117	22.1		55.0	28.6	12.9	4	29.7
Egyptian Amber	21.2		56.0	26.8	8.1	4	28.0
Poole	16.4		59.0	27.5	7.7	4	27.7
Gypsy	17.6		50.4	31.0	9.0	4	27.0
Ped. No. 208 Kharkov	14.9		55.0	24.3	13.6	4	27.0
Ped. No. 10330 Kharkov	21.0		49.7	20.7	15.1	4	26.6
Ped. No. 308, Kharkov	15.1		52.0	23.5	12.4	4	25.7
Tasmanian Red	15.8		48.0	27.6	8.4	4	24.9
Plymouth	15.3		45.3	27.6	10.3	4	24.6
Red Rock	11.4		50.0	25.3	3.7	4	22.6
Craig's Favorite	14.6		45.0	24.6	5.6	4	22.5
Ped. No. 11837	....		50.9	38.6	14.4	3	34.6
Ped. No. 11923 B.	....		49.5	37.3	14.8	3	33.9
Ped. No. 31011—Hybrid	....		50.2	35.6	14.3	3	33.4
Ped. No. 11825	....		49.2	34.0	16.3	3	33.2
Mich. No. 26504	....		....	35.6	17.7	2	26.6
Ped. No. 2, Turkey Red	....		....	29.6	14.0	2	21.8
Mich. No. 28408	....		....	33.6	8.4	2	21.0

TABLE VI—SPRING WHEAT VARIETY TESTS—MARSHFIELD BRANCH STATION

Variety	1913	1914	1915	1916	1917	1918	No. of years	Average
Early Java	31.0	10.8	19.0	13.6	16.6	15.3	6	17.7
Red Fife	24.6	2.7	22.6	15.5	17.9	18.3	6	17.0
Marquis	22.0	5.0	17.9	18.6	18.9	17.3	6	16.6
Minn. No. 169	27.0	3.5	16.8	13.0	16.0	....	5	15.4

TABLE VII—WINTER WHEAT VARIETY TESTS—MARSHFIELD BRANCH STATION

Variety	1916	1917	1918	No. of years	Average
Ped. 10330 Kharkov	27.0	31.7	18.4	3	25.7
Gypsy	36.0	33.5	4.5	3	24.3
Ped. 308 Kharkov	27.0	28.7	13.9	3	23.2
Ped. 208 Kharkov	21.6	30.1	16.3	3	22.6
Tasmanian Red	21.6	24.5	19.7	3	21.9
Ped. 408 Bacska	15.1	33.7	14.6	3	21.4
European Century	24.0	28.9	11.2	3	21.7
Ped. 1045 Kharkov	18.9	27.5	16.3	3	20.9
Craig's Favorite	25.9	25.6	6.9	3	19.4
Ped. 208 Padui	17.0	20.1	20.3	3	19.1
Red Rock	19.9	25.9	6.4	3	18.6
Poole's	16.7	28.9	7.7	3	17.2
Shepherd's Perfection	13.5	24.4	10.9	3	16.7
Ped. No. 2 Turkey Red	....	....	15.2	1	....

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5b

Bulletin 306[1] (55 Soil Series 27)[2] April, 1919

The Soils of Northern Wisconsin

A. R. WHITSON
T. J. DUNNEWALD, CARL THOMPSON

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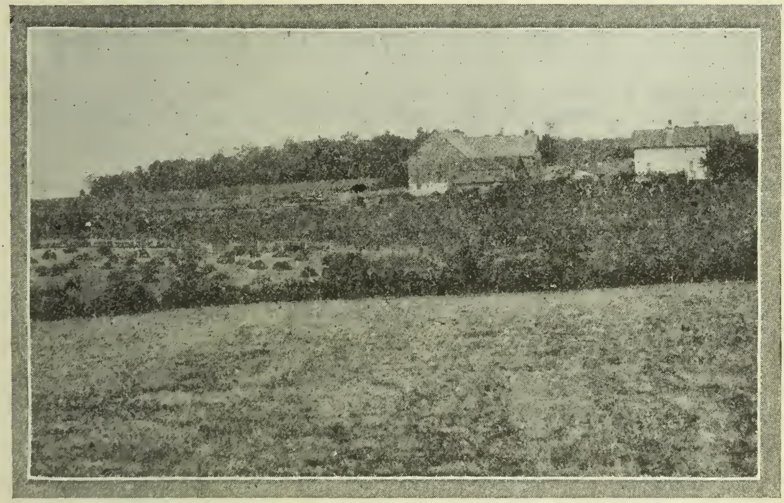

FERTILE SOILS ARE FOUND IN UPPER WISCONSIN

There are thousands of acres of good soil under the brush and stumps of northern Wisconsin. The state has taken the inventory of this soil which helps you select your new farm.

AGRICULTURAL EXPERIMENT STATION
OF THE UNIVERSITY OF WISCONSIN[1]
IN COOPERATION WITH
WISCONSIN GEOLOGICAL AND NATURAL HISTORY SURVEY[2] AND
UNITED STATES DEPARTMENT OF AGRICULTURE
BUREAU OF SOILS

MADISON

DIGEST

The temperature and rainfall in northern Wisconsin are favorable to the growth of clover and pasture, small grains, root crops and many other crops. The rain comes when the plants are making their most rapid growth. While the winters are cold these sections have a clear dry atmosphere. The summers are moderately cool with a uniform temperature. The growing season ranges from 110 to 140 days. Pages 6 to 10.

The fertility of new soils is easily maintained with the right kind of treatment from the start. Livestock plays an important part. Pages 11 to 12.

There are ten principal soil types in upper Wisconsin. These include sands, light sandy loams, heavy sandy loams, silt loam with a well-drained subsoil, silt loam with a heavy subsoil, silt loam on limestone, heavy red clay, poorly drained soils, peat and muck, and rough or very stony lands. Pages 13 to 15.

Sand soils have advantages as well as disadvantages. They do not hold moisture as well, and are more affected by dry weather, and are lower in plant foods than the heavier soils. However, they can make better use of light rains than heavy soils and they warm up more quickly in the spring. While they are not the equal of the heavier soils, when properly managed they produce fair crops of clover, rye, soy-beans, and corn. Pages 16 to 18.

Light sandy loams are finer and hold moisture better than the sands. They have more plant food. The best crops are rye, clover, corn, and soy-beans. Potatoes can best be grown if the fertility is maintained. Pages 19 to 20.

Heavy sandy loam is the most common soil and one of the most valuable in upper Wisconsin. It is well adapted to a wide range of crops. Dairying and potato raising are the two most important lines of farming. Pages 21 to 24.

Silt loam soil with a well-drained sub-soil follow the heavy sands in acreage. They are especially adapted to grass and pasture, small grains, root crops and clover. Dairying and stock raising are profitable on this type of soil. Pages 25 to 27.

The silt loam with a heavy subsoil is one of the most uniform soils in the region. It is fertile and develops into excellent farm land. It is particularly adapted to small grain and grasses. This soil type is often wrongly called a clay loam. Pages 28 to 29.

Silt loam soils on limestone are very fertile. This section is rapidly becoming one of the richest parts of the state. Pages 30 to 32.

A million acres of red clay lies in the Lake Superior district. It is especially adapted to small grain and hay production. Pages 33 to 34.

The poorly drained soils are grouped in two classes: poorly drained sandy soil, and poorly drained heavy soils. Wet lands need drainage before they are of agricultural value. Pages 35 to 36.

Peat and muck lands need drainage and fertilizers. If uncleared they require more effort to stump and brush. They are subject to earlier frosts. Certain crops produce heavily with the proper management. Pages 37 to 28.

Rough or very stony land is best adapted to pasture or forestry purposes. Its value is limited. Pages 39 to 40.

The Soils of Upper Wisconsin

One hundred thousand farms of 80 acres each are waiting the farmer in upper Wisconsin. This land has a good soil, has an abundant rainfall, is close to the railroads, and has access to large markets.

Nearly one half of the 18,500,000 acres in upper Wisconsin is already occupied in farms in all stages of developement—there is left more than 8,500,000 acres of good farm land, as well as 2,000,000 acres suitable only for pasture and forestry purposes.

Upper Wisconsin appeals to the business farmer. The value of the crops produced per acre of improved land in upper Wisconsin is higher than in the southern Wisconsin counties or the average Illinois, Iowa, or Ohio country. Here is the proof taken from the government figures:

In Marathon country according to the U. S. census, the average value per acre of improved land of all crops produced in 1909 was $15.00. In Dodge and Fond du Lac counties, which are two of the richest counties in the southern part of the state, the average value was $14.00 per acre, and in Dane county $15.00 per acre. In the state of Illinois for the same year the average production per acre was $13.00, in Iowa $11.00, in Ohio $12.00 and in Wisconsin $12.00.

Just to see what is being done in developing upper Wisconsin notice the figures taken from the census figures for three periods, 1890, 1900, and 1910. Three of the typical counties in the northern section of the state are shown. These counties have been settled during the past 30 years and are similar in their general character to the lands yet to be developed. Here are the figures:

Development of Typical Counties in Wisconsin.

County	Year	Number of all farms	Acres of farm land improved	Value of all farm crops	Value of all dairy products
Clark	1890	2,086	71,700	....	....
	1900	3,456	120,964	$1,304,210	$305,484
	1910	4,196	151,891	2,151,733	1,171,341
Marathon	1890	2,789	83,863	....	....
	1900	4,276	145,060	1,713,544	282,272
	1910	5,080	184,153	2,758,318	883,816
Barron	1890	1,859	64.618	....	....
	1900	3,004	117,407	1,056,385	196,012
	1910	3,852	170,203	2,156,442	792,647

It will be seen that the land in farms in these counties has about doubled in the twenty year period, that the value of all farm crops has increased about four times in Clark and Marathon counties and more than five times in Barron county in twenty years. The increase in dairy products is even more remarkable. In all of these counties the value of dairy products was more than trebled in the ten year period 1900–1910.

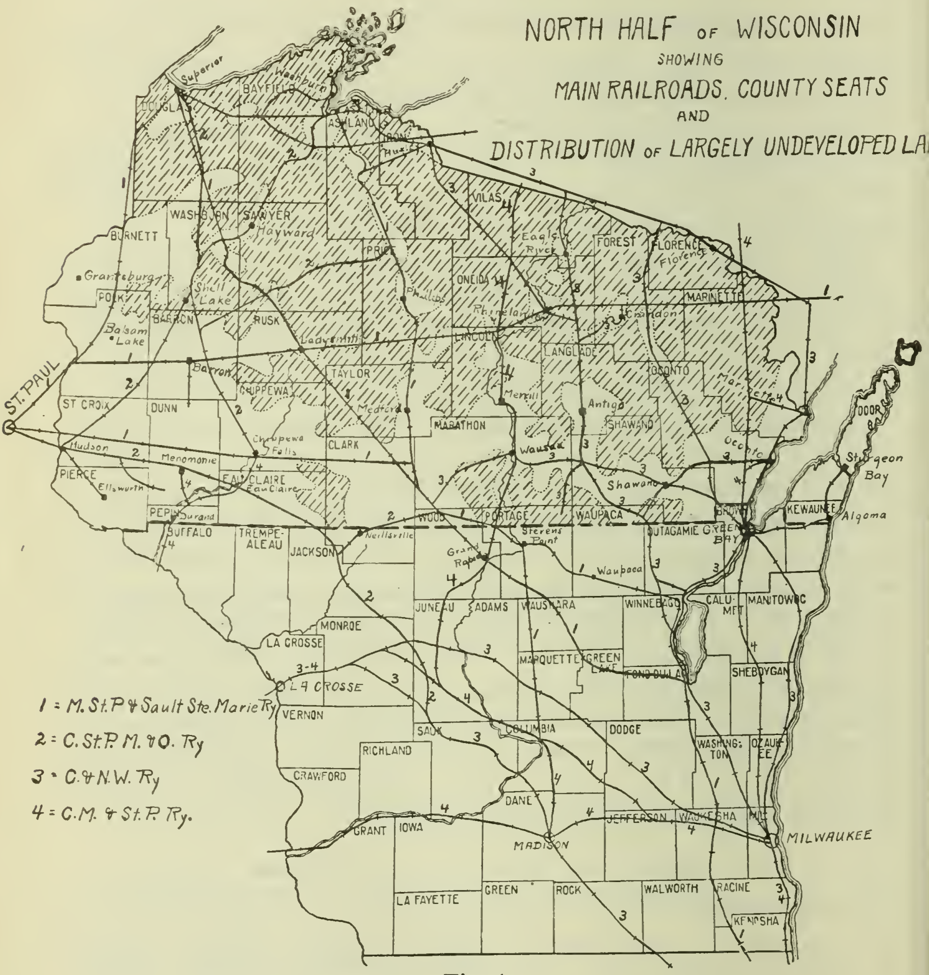

Fig. 1.

There are many different kinds of soils in this part of the state. They vary from heavy clays to light sands. There are considerable areas of level lands although for the most part the country is rolling and in some sections it is very rough and broken. Most of the soils have good natural drainage but some have poor underdrainage and there are considerable areas of marshes. The soils also vary in the amount of vegetable matter or humus they contain.

It is the purpose of this report to describe all of these different kinds of soils and the purpose of the map is to show where the soils are located.

CHAPTER I.

CLIMATE OF UPPER WISCONSIN

The climate of the country, together with its soil, determine the crops which can be grown. By climate we mean the amount and distribution of the rainfall and the temperature.

RAINFALL

In regard to rainfall, both the total amount and the way it is distributed through the growing season must be considered. As an average of the past nineteen years, the total rainfall for the year in northern Wisconsin is just a little under 30 inches. Of this about 21 inches comes during the six months from April 1st to October 1st and the average by months is as follows:

April	2¼ inches
May	3½ inches
June and July	4¼ inches, each
August	3¼ inches
September	3½ inches

It will be seen that the heaviest rainfall comes during midsummer when crops are making their most rapid growth and require the most moisture.

There is of course considerable variation in the distribution of rainfall during the season from year to year and also in the total amount from year to year. Dry spells of two to four weeks in length occur occasionally and at any time of the year, but northern Wisconsin suffers less from such dry periods than most other portions of the country. These dry periods of course affect crops growing on the very lightest soils more than on heavier soils and yet it must be borne in mind that a moderate rainfall of ¼ to ½ inch, coming during a dry period, is more helpful on light soils than on heavier soils because it reaches to a greater depth, and a larger portion of it is available to crops. As a rule, therefore, it is only on the very lightest sandy soil that crops suffer much from drought.

The relative freedom of this section of the country from the hot dry southwest winds which occur in the country farther south also means less loss from drought and the more effective use of the rainfall. The amount and distribution of the moisture is adapted not only to the growth of grain and cultivated crops, but is such as to secure exceptional pasturage and in the great majority of years a good second growth of clover.

There is no other section in the country in which the distribution of rainfall is better adapted to agriculture than in northern Wisconsin. There is less rain in the spring when the ground is to be seeded for crops than in the eastern states and there is more rain when needed by the growing crops in the summer than in the western states.

TEMPERATURE

The temperature of a country more completely controls the crops which can be grown than anything else. Each crop has its particular needs in regard to temperature. The temperature of northern Wisconsin is characterized by cold winters with clear dry atmosphere, and summers of moderately cool but quite uniform temperature. This climate is particularly adapted to the growing of small grains and of grass for pasture and hay. The cool temperatures of the spring months are extremely favorable to the germination and stooling of the small grains and the cool moderately moist atmosphere of the remainder of the season causes them to fill well and yield headily when the soil is properly tilled and its fertility maintained.

The temperature conditions are also very favorable to root crops. Sugar beets yield a very high percentage of sugar and rutabagas make exceptional growth during the fall period. The quality of potatoes is the very best. The climate is also well adapted to cabbage and celery.

CORN IN UPPER WISCONSIN

The temperature conditions of northern Wisconsin are not so favorable for corn as for small grains. Early varieties of corn require about 100 days to ripen. The line having an average of 130 days without killing frost, running thru Polk, southern Chippewa and Lincoln and central Marinette counties, marks the northern limit of the section in which early corn will be uninjured by frost, four out of five years. North of this line the risk of injury by frost becomes greater, but during fully half the seasons corn will reach a good silage state. Local conditions such as the character of the soil and the lay of the land have an important influence on possibility of maturing this crop. In the same location and situation corn will mature in from ten days to two weeks less time on sandy soils than on heavy silt loam soils, which amounts to the same thing as lengthening the season free from frost by that number of days.

The hilltops and upper slopes, because of the smaller liability of frosts occurring in these situations, act similarly to lengthen the growing season locally.

FROSTS

The influence of local conditions on the occurance of light summer frosts must be considered. Low land soil which is wet and cold is more liable to frost than dry land. Peat soils which are loose and do not let the heat penetrate the body of the soils, lose their temperature more rapidly at night and are therefore in danger of frost more than earthy soils. The tops and upper slopes of hills are much less liable to the occurance of these frosts because there is opportunity for the cold air to drain down the slope and away from the crop. Corn and other tender crops can, therefore, be grown on upper hillsides and hill tops with much less danger than on lower ground. The influence of the large lakes on temperature is also considerable. The cool air from Lake Superior in particular makes that section less well adapted to corn than the country fifteen to twenty-five miles away from the lake. The temperature effect of the lake is intensified by the heavy clay soils of that section, while on the other hand, these very conditions make that section especially adapted to the small grains, grasses and many of the hardier vegetables.

THE GROWING SEASON

The average length of time between killing frost in the spring and in the fall is shown on the accompanying map. This map shows the number of days on the average year during which corn or other tender crops will grow. It should be remembered, however, that there would be too much risk taken if one were to grow varieties of corn which would require the number of days indicated on the map to ripen, since that would mean that these varieties would be killed on an average every other year. If we assume that we can take the risk of a frost killing corn one year out of five, then the length of growing season would be about thirty days less than indicated on the map.

Long Season For Pasture and Most Crops. The light frosts in the spring and fall which are sufficient to kill corn or other tender crops do not interfere seriously with the growth of grass for pasturage or hay or of small grains or hardier root crops and vegetables. For the growth of these crops the season is of course much longer than for corn.

Good pasturage begins in northern Wisconsin about the middle of May. This is nearly two weeks later than the beginning of pasturage

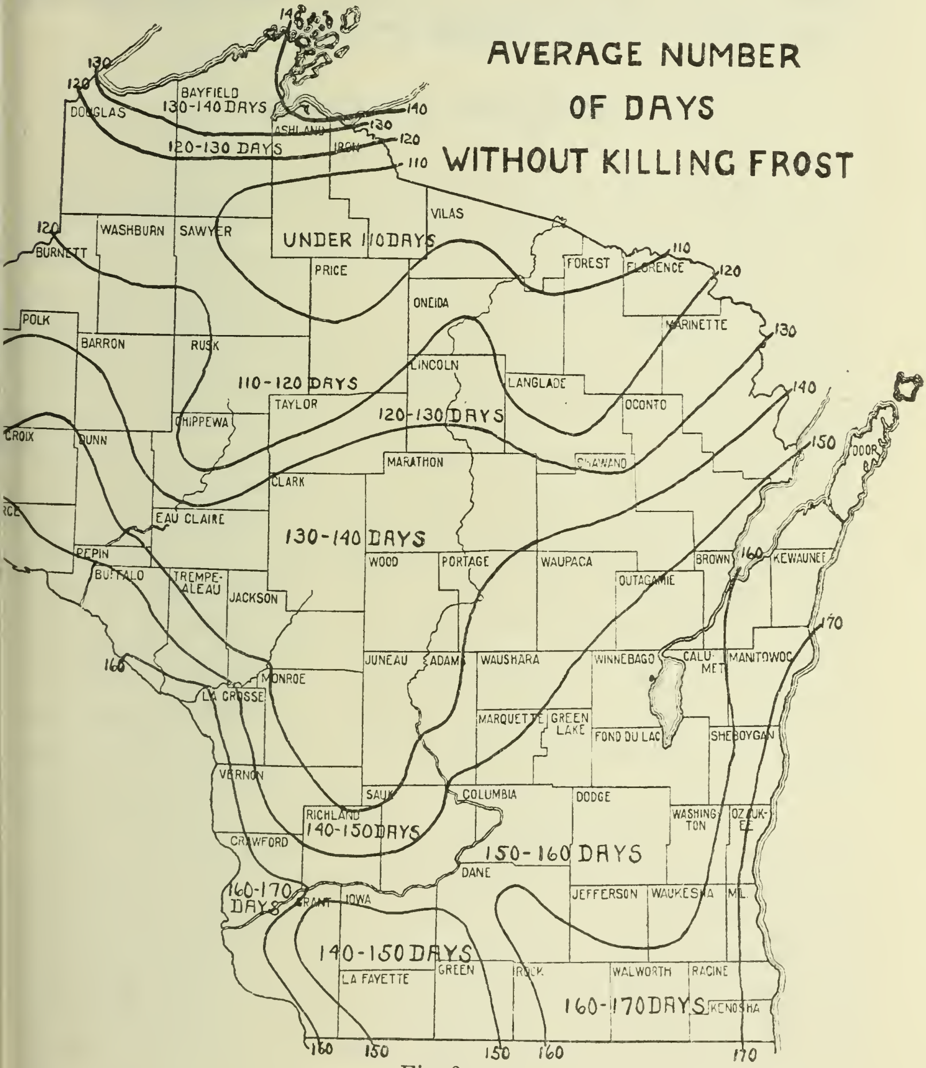

Fig. 2.

in southern Wisconsin, southern Minnesota, or northern Iowa. But the shortage of pasture due to drought in northern Wisconsin is so much less on the average than in the southern part of the state, during the early fall especially, that the total pasture season is probably nearly or quite equal to that in the southern section and certainly much longer than that in the prairie sections to the southwest. The amount of feed necessary to carry the stock through the winter and dry periods is therefore not greater in northern Wisconsin than in other sections of the state and adjoining states, which have already become the chief dairy sections of America. Corn for silage must to some extent be replaced by hardy root crops.

CHAPTER II.

KEEPING UP FERTILITY

Farmers starting on new land should make an effort to keep up and increase the fertility of the soil from the beginning rather than to let it run down for several years until the crop yields are small and more expensive methods are necessary to build up the fertility again. In order to maintain the fertility of the soil it is necessary to keep a supply of organic or vegetable matter in it which by its decomposition will furnish growing crops with nitrogen and cause chemical changes in the soil by which other elements become available to growing plants. This organic or vegetable matter may be either stable manure or green manure such as clover, or other crops, or straw and stubble left from the growing of grains. Legumes such as clover, soybeans, etc., are the best for green manuring purposes and also most helpful in keeping up the nitrogen supply of the soil, when fed to stock, because of the fact that they are higher in nitrogen than other crops and secure this element from the air so that growing them adds to the quantity of nitrogen in the soil on the farm, whereas the growing of other crops tends to reduce the quantity of nitrogen. The growing of legumes therefore is important in any system of farming unless a large amount of expensive fertilizers containing nitrogen are bought, which under northern Wisconsin conditions is unprofitable.

Other important elements of plant food are phosphorus potassium and calcium or lime. Phosphorus exists in very small amounts in all soils and is used by every growing plant. It accumulates largely in the seeds of plants as they ripen and so after grain is sold there is considerable loss of phosphorus and even if the grain is fed and milk or the entire animal sold the phosphorus is taken away in the milk or bones of the animals. While there is enough phosphorus in most soils to last a good many years, without purchasing a new supply in fertilizers, still yields will not be so large and will gradually decrease unless new supplies of phosphorus are secured. There are, however, enormous stores of phosphates which are being mined and these together with bones of animals from the slaughter houses are available for keeping up and increasing the phosphorus content of the soil. The best yields of the best grades of grain and other crops can only be secured by keeping up the supply of this element.

Potassium exists in large amounts in all earthy soils but occurs in small amounts in such soils as peat and muck which are largely made up of vegetable matter. The potassium in clay and silt or earthy soils becomes available through the action of decomposing organic or vegetable matter and this action is one of the most important reasons for keeping up the organic matter of the soil. Some crops need much more potassium than others. Potatoes, cabbage and root crops use large amounts and it is frequently desirable to use potassium fertilizer to increase the yields of these crops. Marsh soils are low in potassium and potash fertilizers should be used on them.

Calcium, the chief element in lime, is needed by all crops though some use more of it than others. Alfalfa, clover, peas and beets are among those using the largest amounts. Lime containing calcium is lost by leaching, as well as by removal by crops and hence best yields especially of crops using considerable amounts of lime are only possible over a long period of years when lime is returned to the soil. Limestone rocks which need only to be crushed and ground occur in southern and western Wisconsin and the application of a ton of lime to the acre every four to six years will greatly improve the fertility of the farm at a small expense.

Live Stock Raising Compared with Crop Selling. It is quite often stated that the keeping of live stock is necessary in order to keep up the fertility of the soil of a farm. This is not true. It is just as easy to keep up the fertility by using green manuring crops and commercial fertilizers as by using stable manure. There is, however a large opportunity to use the time during the winter in the care of stock and secure some profit by feeding the crops grown and farmers who have means to purchase stock and who can feed profitably should certainly do so. A large amount of excellent pasturage can also be secured on new land in the process of clearing which would otherwise be wasted.

It is in fact chiefly because land can be used in pasture in this condition that land in the cut-over sections is cheap in comparison with fully developed land elsewhere.

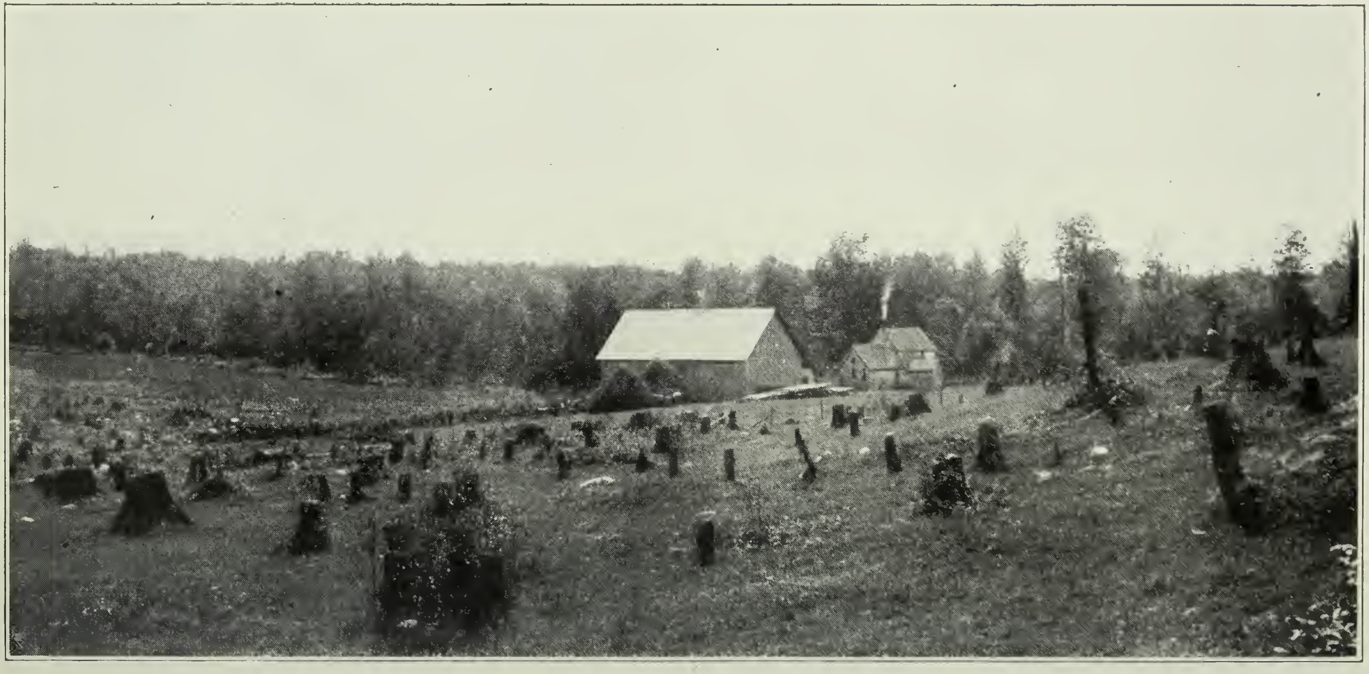

FIG. 3.—A FARM IN THE EARLY STAGES OF DEVELOPMENT

Note the small cultivated acreage, the stump land pasture and the timber in the background.

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CHAPTER III.

KINDS OF SOIL

There are a great many different kinds of soil, probably a hundred different kinds could be distinguished in the State of Wisconsin.

On this map, however, we have grouped these into ten classes, but most of these classes are subdivided into two or three phases, to take account of differences in the lay of the land, or topography, and other characteristics. The grouping into the ten classes is chiefly made on the basis of the fineness of grain of the soil. This is generally called its texture. This quality of the soil is most important because it is the chief thing which determines the kinds of crops to which the soil is adapted. Sandy soils, for instance, will grow fair crops of a few kinds, such as rye, mammoth clover, and corn, if their fertility is kept up, but they will not grow good pasture grasses because they do not hold enough moisture. On the other hand, silt loam soils or heavy clay soils will carry excellent pasture grasses and are well adapted to small grains, but are not adapted to potatoes, soy beans, and some other crops; while heavy sandy loam soils will hold enough moisture to grow good grass and small grains, but are also light enough to be well adapted to potatoes, corn, clover, and other crops which do not grow well on the heaviest soils.

On account of the importance of the fineness of grain, or texture of the soil, this is made the chief basis of classification. The particles or grains which go to make up any soil can be separated into three grades or sizes,—first, sands; second, silts; and third, clay. Sandy soils have large amounts of sand with very small amounts of silt and clay. Light sandy loam soils have somewhat less sand and more silt and clay than the sands. The heavy sandy loams have less sand than the light sandy loams and more silt and clay. Silt loam soils have very large amounts of silt with a relatively small amount of sand and some clay; while in clay soils there is a large amount of clay, some silt, and relatively little sand. To which of these classes a soil belongs is determined by a mechanical analysis in the laboratory.

In addition to the texture of the surface soil, it is necessary to take into consideration the character of the subsoil because this influences the drainage of the soil. Whether there is lime in the soil or not makes a difference which is also shown on the map.

Taking these matters into consideration with the texture we have the soils subdivided into the sands, fine sandy loams, heavy sandy loams, silt loams with well drained subsoil, silt loams with heavy subsoil, silt loams on limestone, and heavy red clay. Each of these classes is subdivided into two or three phases depending on the lay of the land, or topography, there being a level phase of sandy soil, and an undulating to rolling phase, and so on with the other classes.

In addition to these classes, the map shows poorly drained soils subdivided into (1), those which are rather sandy; (2), those which are heavier, as sandy loams and silt loams; and (3), peat and muck. The rough, or very stony land has two groups; (1), those which are too sandy to support grass for pasture; and (2), the heavier soils which would be well adapted to pasture.

HOW THE MAP WAS MADE

The men who made the soil map went over all of the roads, and where the roads are a good way apart they went over every other section line. In this way they saw a part of every section, but they did not see every quarter section. There are, therefore, a great many pieces of land, some as large as half a section in extent which may not be exactly as represented on the map. This must be borne in mind in using the map. But the map does show the location of all large areas of the different kinds of soil; so that it is comparatively easy for anyone with a map in hand to decide where he should go to look for soils of the kind he wants.

In mapping the soils the men used augers welded to steel rods so that they could bore into the soil and subsoil and determine its nature.

It is impossible to show the degree of stoniness on the map as that varies within very short distances. On some patches the stones are too thick to make clearing practicable. Some of these patches are as large as 40 acres in extent.

It is therefore very important for anyone in examining the piece of land he is thinking of buying to go over it carefully to see just what the lay of the land is, the amount of stoniness, and the thickness of the stumps.

The following pages describe these different classes of soils, and give general information in regard to the other matters above mentioned.

RELATION OF SOIL TO LINE OF FARMING

Each different kind of soil is adapted to some crops and some lines of farming better than to others and as far as possible the crops best adapted should be grown. It is only when working with Nature that we can expect the best results.

One looking for land should first decide the kind of farming he wants to engage in. If he decides to make stock raising the chief line, whether as dairying or for beef or mutton, he should select land which will best grow the crops he wishes to feed. He should also as a rule, at least in the northern part of Wisconsin, select land which will give good pasture. This means that the land should be not lighter than heavy sandy loam. If he wishes to grow wheat, barley or oats to a considerable extent for sale, he will find silt loam, clay loams, and clay the best soils for his purpose. If potatoes is to be the chief cash crop then he should select a light sandy loam or a heavy sandy loam. The heavy sandy loam soil is adapted to the largest variety of crops and lines of farming. With the large variety of soils in Wisconsin, good locations for any important line of farming to which the climate is adapted can be found. These relations between the soil and crops and lines of farming are fully pointed out in the description of each class of soil in the following pages.

CHAPTER IV.

SANDS

The sand soils of upper Wisconsin have been put into two classes: i. e., those which are level or nearly so, and those which range from just a little rolling, or undulating, to rolling. The roughest sand soils which are better suited to forestry than farming are classed with ROUGH AND VERY STONY LAND on the map.

A large part of the sand soils shown in Burnett and Douglas counties are finer than the average of the Sands, and have therefore, somewhat higher value than the average of sands in other portions of the northern part of the state.

The original timber on the sands was largely Jack and Norway pine with a small amount of White pine. The growth of timber, however, was comparatively light and since practically all the timber of value has been removed, there remains only a scattering growth of smaller Jack and Norway pine, with which is mixed some Black oak, poplar, birch and cherry.

THE VALUE OF SAND SOILS

Sand soils have less producing power than heavier soils, first, because of the fact that they do not hold moisture as well and so are somewhat more subject to drought, and second, because they contain less plant food as shown by chemical analysis.

The fact that sandy soils hold less water from rains makes it possible to work them immediately after it stops raining; so that much time can be used in cultivation and other field work on sandy land which cannot be so used on clay soils. Moreover, light rainfalls which are not sufficient to wet heavy soils down far enough to reach the roots of crops do penetrate the sandy soils far enough to be of great help to growing crops. This is a decided advantage possessed by sandy soils. Moreover, this same tendency to dry out more readily than heavy soils permits them to warm up much more quickly in the spring; so that crops can often be planted a good many days earlier on sandy soils than on heavy soil. This is especially true in regard to corn in the northern part of the state and it often happens that corn is planted enough earlier on sandy soils to mature before frosts; when on heavy this would be impossible.

While these soils will probably never have the selling value of heavier land, they still have considerable possibilities for agricultural use. When properly managed, fair crops of clover, rye, soy beans and corn can be grown on these sandy soils. With good management the yields of these crops on sand soils can readily be made to average two-thirds the yields of the same crops on heavy soil, and considering the small capital invested and the lower cost in operation, fair profits are possible on these soils. But it must be remembered that clover, soy beans, or other legume crops which have the power of fixing nitrogen from the air must be grown right from the start. If rye, corn, potatoes, and other crops are grown for several years after breaking without legumes, the land quickly becomes run down so that much more expense is involved in building it up.

These soils do not support good pasture grasses; so that corn or other fodder must be used in the summer during dry periods. Again, this land does not as a rule maintain a sufficient degree of fertility to warrant the growing of potatoes for sale. A system of farming including a rotation of rye, clover and corn, and the keeping of as many dairy cows or other stock as can readily be fed, is the best general plan for farming on these soils.

Handling and Fertilizing Sand Soils. Somewhat different practice in regard to plowing and seeding than that usually used on heavy soils is called for. Seed should be placed more deeply on sandy soils, and the use of a roller, especially one of the corrugated type, is very beneficial in giving a greater degree of firmness to the seed bed. The use of some ground limestone to neutralize acidity and of small amounts of commercial fertilizer, especially those containing phosphorus, will help greatly to build up the producing power of these soils.

Two Kinds of Sand Soils. While the level sands have been separated on the map from those which are undulating to rolling, the difference between these, as far as their value and use in farming is concerned is not great. The **level sand soils** are more easily farmed than the rolling lands, and when they have the same degree of fineness, will retain water somewhat better. Occasionally, two or three feet below the surface the sand becomes much coarser or is even a fine gravel, and this, of course, greatly reduces its value. One should examine the subsoil of these lands to determine whether this coarse material is found in the subsoil or not. On the other hand, even a thin layer of silty or clayey material in the subsoil helps to hold the water. These areas of sandy soils occur especially in the valleys where they were deposited by running water.

The **undulating** to **rolling sand soils** vary greatly in roughness. Some have gentle slopes so that farm machinery can be used about as easily as on the level sands, but some areas are quite rough. Where these occur in large tracts they are shown on the map as the **rough lands**, but when they are in small areas of forty to eighty acres along with more gently rolling or level sands, they have not been separated. These rolling sandy soils vary in degree of fineness more than do the level sands, and seldom become much coarser in the subsoil. But they are sometimes rather stony while the level sands are practically free from stone.

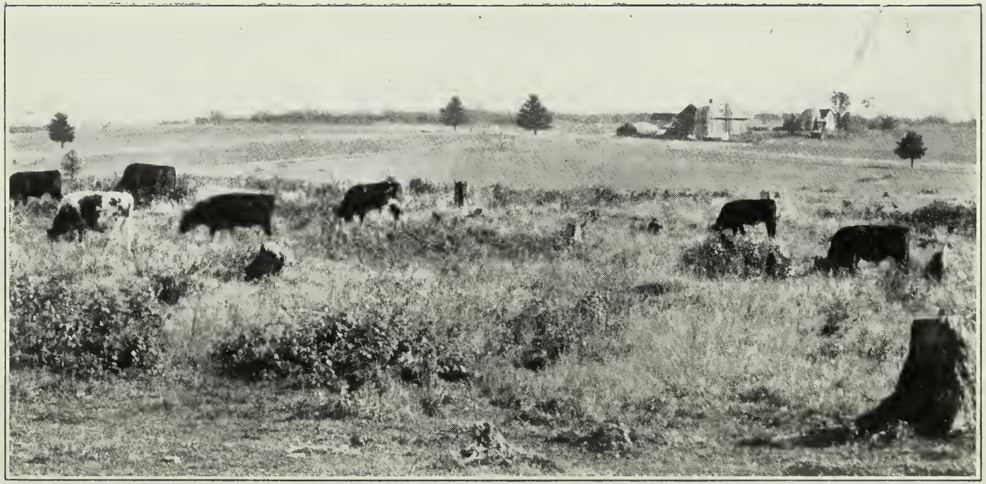

FIG. 4.—THE SECOND STAGE IN THE DEVELOPMENT OF A FARM IN NORTHERN WISCONSIN

Part "brushed" stump land pasture, part cultivated, a profitable combination.

CHAPTER V.

LIGHT SANDY LOAMS

These soils, while still quite sandy, are finer and hold moisture better than those classified as sands. They also have somewhat more fertility. One must note the texture or degree of fineness carefully to appreciate the difference in these soils, because relatively small differences in degree of fineness are important.

LEVEL AND UNDULATING LIGHT SANDY LOAMS

While the map shows the level and undulating portions of the light sandy loams separately the difference between these, so far as their value and use in farming is concerned, is not great. The level phase is usually quite free from stones and is apt to get a little coarser in the subsoil than is the case with the undulating phase. The latter, in some sections, is more or less stony. On account of the relatively little difference between the level and undulating phase they will be discussed together.

Considerable variations in the texture of these light sandy loams occur within short distances. Often the quality of the soil on one forty-acre tract is distinctly better than that on the adjoining forty acres. Some variations occur in the general character of these soils in different parts of upper Wisconsin. In the Chippewa River valley in Rusk county, the soil is quite variable, being more sandy near the small tributary streams and heavier farther back. In the southern half of Oconto county there is considerable limestone gravel which improves the character of these soils. In parts of Langlade, Forest, Pierce, and Barron counties, these soils are apt to be more stony on the more hilly portions.

The light sandy loams originally supported somewhat heavier timber than the sands described on the preceding pages and a larger portion of it consisted of Norway and White pine. There is also a small amount of basswood, hemlock, oak and birch. The second growth which now covers most of this land consists of oak, poplar, white birch, and pine from ten to thirty feet in height. The supply of firewood is, therefore, generally sufficient on this class of lands to meet the needs of settlers for some time. The labor involved in clearing is moderate, on account of the comparatively light growth of timber in general, but is of course somewhat larger than on the sands.

VALUE AND USE OF LIGHT SANDY LOAMS

These soils have a distinctly higher value than sands. The staple crops should be rye, clover, corn and soybeans. These soils, however, will grow good crops of potatoes when the fertility is maintained and many other special crops can be grown. This soil is not sufficiently heavy to support good pasture grass and other forage should be grown to supplement pasturage in the summer.

While these soils are not especially adapted to stock raising or dairying, a moderate amount of stock can be kept on new farms where some pasturage is available in land not well enough cleared to be broken or cultivated.

KEEPING UP FERTILITY

Manure is of great assistance in keeping up the fertility of the soil, but it must be remembered that when heavy crops, such as potatoes and root crops, are sold from the farm, the use of some fertilizer in addition to stable manure is desirable.

Most of these soils, in common with soils of the northern half of the state generally, are somewhat acid and crops needing large amounts of lime, such as alfalfa, soybeans, and mammoth clover will require its use in order to secure good yields. Clover usually does well on these lands for several years without liming, but will in all probability be benefited by the use of moderate amounts of lime after a few years of croping. Plowing under a second crop of clover, or still better, the growing of a crop of soybeans or other legumes to be plowed under entirely as a green manuring crop in addition to the growing of clover for hay, is very helpful in building up the organic matter of the soil. This practice has been found to pay for itself in the increased yields of potatoes and other crops. Moderate amounts of phosphate fertilizers will prove profitable, although they are not necessary to secure fair yields for the first few years.

CHAPTER VI.

HEAVY SANDY LOAMS

The most common class of soils through upper Wisconsin is the heavy sandy loams. These soils are among the most valuable farm lands in this part of the state. They are intermediate in texture being sufficiently heavy to carry good pasture grass, and yet have a sufficient amount of sand and gravel in their composition to give them good under drainage; so that they warm up more readily in the spring than do heavier soils. Crops growing on them have a distinctly longer growing season than on heavier soils which is of great importance in the latitude having a relatively short growing season. Their adaptation to a wide range of crops still further increases their value. Their texture also gives them a good mellow tilth and makes them easy to work; so that they are adapted to special crops such as potatoes, and root crops generally, as well as to the staple crops including clover, timothy and small grains.

The original timber on these soils consisted of a good growth of mixed pine and hardwood. The pine was chiefly White with some Norway and a small amount of Jack pine. In some sections there was a heavy growth of hemlock on these soils. The hardwood included a mixture of birch, maple, basswood, and a little oak. Since most of the pine on this soil was merchantable timber, it has been cut, except in limited localities, and only a little second growth pine and the hardwood remains. The hardwood, however, is sufficient to supply an abundance of firewood in practically all sections and there is often considerable cordwood available.

The fairly heavy growth of timber on this land means, of course, that the clearing is moderately heavy compared with lighter soils, although small tracts are frequently found which have been burned over to such an extent that the labor of clearing is considerably reduced.

Two groups of heavy sandy loams are shown on the map. The level, or nearly level phase occurs only in limited areas, but the undulating group, which is by all means most common, is found in large widely distributed bodies.

UNDULATING HEAVY SANDY LOAMS

Soils of this class are, for the most part, undulating to rolling in topography. In some sections especially in the northern part of the state, the land may even be called rough and hilly, but for the most part it is not so rough that it would prevent good agriculture development. Hilly land, too rough for cultivation, should be used as pasture and farmed with other land. The hilly land should be cheaper.

Stoniness varies greatly over the areas occupied by these soils. In some sections large cobbles and bowlders are so numerous as to make clearing very expensive, but this is true only on a small fraction of the land and in most cases extreme stoniness occurs only over patches of a comparatively few acres; so that by using these portions for pasture, the land as a whole may be developed.

There is quite a little variation in the subsoil of this class of soil. Near Superior in Iron county, there is a tract of about 12 sq. miles, the soil of which is underlaid by clay at from 24 inches to 26 inches. This gives the soil of this tract a considerably heavier character in general and less thorough underdrainage than the rest of the undulating sandy loams.

In central Ashland County there are about 50 sq. miles of this soil which is very stony. In the so-called iron ranges, hard granite rock underlies the rougher and more hilly tracts. In Ashland county the Penokee iron and copper ranges are accompanied by a belt of hilly and stony land, which is about one mile wide. Other tracts of stony land occur in certain parts of Burnett, Washburn, Marinette, Shawano, and Sawyer counties and the stoniness varies within very short distances so that it cannot be shown on the map. Many of the most stony of these tracts can be used only for pasture and wood lots but when the farm includes a sufficient amount of good land to raise crops for feed, good results can be secured.

A tract of about 50 sq. miles in Price and Oneida counties and one of about 25 sq. miles in Burnett county have a heavier subsoil, which is reached at a depth of from 18 inches to 36 inches. A large tract of about 100 sq. miles between Webster and Grantsburg has a heavier subsoil which generally comes to within 8 inches to 24 inches of the surface and gives the soil rather poor drainage in those tracts which are level. After some attention has been given to the drainage of these tracts, this soil will be greatly improved in character and will be better adapted to pasture and to small grains than the soils of this type generally are, while the fairly light character of the surface soil makes them still well adapted to potatoes and other special crops which do best on soils of a medium texture. In Chippewa, Eau Claire, and Dunn counties, this class of soil is relatively free from stones and of excellent character, but somewhat more hilly than in other regions. Here practically all of it has already been developed into farms.

The rolling surface of these soils gives them better air drainage than more level land has, and corn, potatoes, and other crops easily injured by frost can be grown on the side hills successfully in even the northern part of the state, although on flat land in the same section, their growth may be attempted with much greater risk. The loamy texture of the soils further tends to make them warm and so adapted to tender crops.

LEVEL HEAVY SANDY LOAMS

As shown on the map, the level heavy sandy loams occur over small areas in different counties. Most of the land of this type was formed by the filling in of shallow lakes and streams. These soils are usually quite free from stone, have a level or gently undulating surface, and the subsoil is usually lighter or sandier than the surface soil.

Their level surface and comparative freeness from stones gives these soils a higher value for general farming. Their lighter subsoils, for the most part, give them good underdrainage, though there are some local areas which need some attention to secure good surface drainage. These soils are well adapted to grass, hay, or pasturage, and to the small grains and are especially well adapted to potatoes, except as an occasional severe summer frost interferes.

CALCAREOUS HEAVY SANDY LOAMS

A belt of soils having the texture of heavy sandy loam occurs in a strip west of Green Bay in Marinette, Oconto and Shawano counties. This soil is similar to the heavy sandy loams described above, except that it contains a good deal of ground limestone and limestone pebbles, especially in the subsoil, having been formed by glacial ice passing over a country of limestone rocks. The presence of this limestone in the subsoil lessens the tendency of the soil to become acid and gives it an added value. This soil is one of the best types in the state. It is adapted to practically all the crops which grow in this climate—corn, root crops, small grains, grasses and legumes—and has the advantages of heavy sandy loams pointed out in the description on page 21. The presence of the limestone makes it especially adapted to the growing of alfalfa, peas, and other crops needing large amounts of lime. Orchard crops, particularly apples, also do unusually well.

Most of the surface is undulating to rolling with long gentle slopes so that farm machinery can be used on practically all of it, though there are a few small areas where the surface is somewhat choppy. The underdrainage is good except on a few tracts which are chiefly confined to Green Valley Township in Shawano county and to small scattered areas in Oconto county, chiefly in Morgan, Oconto Falls, Gillett, and Stiles Townships. These tracts will need dranage for their improvement.

In the western part of Polk and St. Croix counties is a similar belt of this soil with limestone gravelly subsoil. The majority of this area has a rolling to hilly surface but includes many nearly level areas. The surface soil is more sandy in portions than in others. Large areas of the hilly sandy loam occur in the Town of Somerset, St. Croix county, and around Dresser Junction in Polk county. Stones and boulders are usually plentiful on the surface and stone piles and stone fences are common. Areas of considerable size are practically stone free.

CHAPTER VII.

Silt Loams With Well-Drained Subsoils

The silt loam soils with well-drained subsoil are next in abundance to the heavy sandy loam soils in upper Wisconsin. These silt loam soils are quite generally called clay loam but it is important to distinguish them from clay loam soils which are considerably heavier. A soil of silt loam texture has high water holding capacity and is therefore, well adapted to grass and pasturage, and to small grains, but it is not too heavy to work well when sufficiently well drained; so that it is also suited to crops needing cultivation.

ROLLING SILT LOAM

The larger portion of these silt loam soils in upper Wisconsin are undulating to rolling in topography. They occur in large tracts in Florence, Forest, Langlade, and Marathon counties in the eastern part of upper Wisconsin, and in Sawyer, Rusk and Polk counties in the western part. These soils were formed by glaciation chiefly from granitic rocks and so bowlders and cobbles are quite generally distributed through them. Stoniness varies greatly so that tracts of moderate size are occasionally found which are too stony to be readily cleared, but for the most part, stones do not form a serious obstacle. The rolling surface gives good surface drainage on practically all of this land, but some small tracts where the subsoil is too heavy to permit of good underdrainage would be benefited by tile drainage.

The original timber growth on this class of soil consisted for the most part of hardwood, especially maple and birch with some basswood and oak and of soft wood, especially large White pine and hemlock. In Chippewa, Barron, Eau Claire and Dunn counties the timber is largely oak with some maple and poplar. In some areas White pine greatly predominated over the hardwood and the removal of the pine stumps, of course, adds considerably to the cost of clearing the land. On practically all new land there is a sufficient amount of small timber left to furnish stovewood and frequently considerable amounts of cordwood, and bolts of paper wood can be cut which in part meets the expense of clearing. Rough lumber for building purposes can also usually be secured.

VALUE AND USE OF ROLLING SILT LOAM

These soils are especially adapted to grass, both for pasture and hay and to clover, small grains, and root crops. Dairying and stock raising are, therefore, the chief lines of farming to which this soil is adapted with the raising of small grain as a side line. While good yields of potatoes can be grown, the heaviness of the soil makes it somewhat difficult to harvest them properly especially during wet falls. Corn can be grown readily, especially on the higher slopes where the air and water drainage are good, while on the lower slopes or more level portions the heaviness of the soil interferes somewhat with the growth of this crop, which requires a quick and warm soil in this section.

The tracts of this class of land in different sections of the northern part of the state differ somewhat one from another. In the southeastern and northern portions of Ashland county the rolling phase of this soil is more hilly and rough than the average and there is more stoniness and the subsoil is more gravelly. But with the exception of small tracts where bowlders are too numerous all the land can be farmed.

The map shows considerable areas of this silt loam soil with well drained subsoil in northeastern Chippewa, western Rusk, northwestern Barron, and over a large part of Polk county. This soil is, for the most part, of excellent texture and high agricultural value. The survey of this section was made a few years before the remainder of the state and in somewhat less detail so that some tracts are included with this type of soil which really belong to others, but they are of relatively small extent. Most of this section is already fairly well developed.

In the northeastern portion of the state, especially Forest, northern Shawano and Oconto counties, the land of this class is more rolling and numerous long high hills underlaid by granite rock occur. The soils of most of these hillsides is excellent, though occasionally patches are found which are so stony as to make clearing expensive, but these long slopes give good air and water drainage and there is less danger from frost than on the lower land. Some tracts are more stony than others, among which might be mentioned an area of about ten square miles in the northeastern corner of Oconto county and one of about the same extent southeast of Marathon in Marathon county.

LEVEL SILT LOAM

Tracts of level or very gently undulating silt loam soils occur in a few sections as shown on the map. The largest areas of this kind are in the vicinity of Antigo in Langlade county and Milltown in Polk county. These tracts have a level surface and are of alluvial origin, having been formed from the settling of sediment in shallow lakes at the edge of the ice during the glacial period, and very commonly have some sand and even gravel in the deeper subsoil. They are practically free from stone of any size on the surface. The level character of these tracts and freedom from stones gives them considerable advantage in the readiness with which farm machinery can be used and so they have somewhat higher value, except where the unusual number of large pine stumps make clearing expensive. For the most part, the under drainage of these soils is good on account of the sand or gravel in the subsoil, but it is often necessary to provide some small surface ditches to remove surface water quickly in the spring.

These soils are especially adapted to grass and hay and to small grains. Corn is less successful because of their tendency to be a little colder and more backward in the spring than higher land. Root crops do exceptionally well.

LEVEL PRAIRIE SILT LOAM

Some tracts of level silt loams which occur in the western portion of the state, are quite dark or nearly black from the large amount of humus. These tracts were originally prairie soils. They are very fertile and adapted to the growing of most staple crops. Soils of this description are already very extensively developed and improved and so do not call for a further description here.

CHAPTER VIII.

SILT LOAMS WITH HEAVY SUBSOIL

One of the most important and uniform types of soil in northern Wisconsin is the silt loam with heavy subsoil. This covers an extensive area in Wood, Clark, Marathon, Taylor, Lincoln, Rusk and Price counties. This soil is often spoken of as a clay loam, but should really be called a silt loam, since it usually contains from fifty to sixty-five per cent of silt. The soil is relatively free from stoniness. Two phases or kinds of this soil are shown on the map, the rolling, and the level. Both phases are generally fertile and are being developed into excellent agricultural land. The fine texture of the soil makes it especially adapted to small grains and to grass, both for pasture and hay. The soil is not high in its content of vegetable matter and means of increasing the vegetable matter should be used. This soil is also acid or sour and crops requiring considerable lime such as alfalfa, clover, sugar beets, etc., will be greatly benefited by the application of lime. While clover succeeds very well on comparatively new ground, it is probable that the need of lime, will become more apparent as time goes on.

The original timber on this land was mixed hard and soft wood. In some sections the hardwood which included maple, basswood, birch and some oak predominated, while on others White pine stood very thick and constituted the chief timber. On such tracts clearing of the large White pine stumps makes the expense of improving the land rather high. On more level portions in addition to White pine, there is considerable hemlock, balsam, ash and elm.

ROLLING SILT LOAM

The portion of this silt loam mapped as the rolling phase consists largely of rolling hills of moderate height having smooth uniform slopes practically all of which can be readily farmed. In fact, the slopes are just sufficient to give good surface drainage, and to give good air drainage from the higher portions. Rolling silt loam is therefore less subject to frost and has good drainage; so that the earliest varieties of corn usually mature and practically always reach a good silage stage before fall frosts.

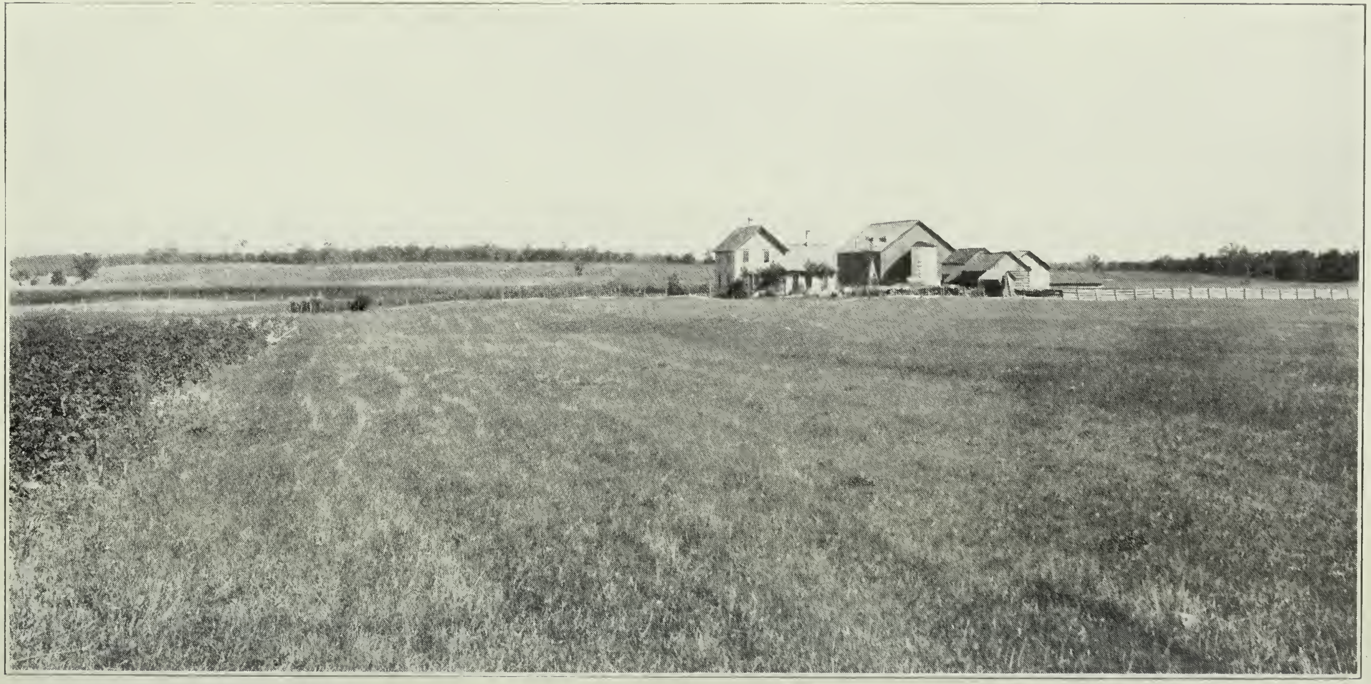

FIG. 5.—A HIGHLY DEVELOPED FARM IN NORTHERN WISCONSIN

At this stage a large part of the farm is covered by the rotated crops of hay, pasture, corn or potatoes and grain.

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LEVEL SILT LOAM WITH TIGHT SUBSOIL

This silt loam occurs extensively in eastern Rusk and southern Price counties. This is a fertile soil, especially adapted to the small grains and grass for hay and pasture. The level character of the soil itself causes it to be rather poorly drained during wet seasons. Surface drains in the form of shallow ditches connected with dead furrows should be used to remove surface water as much as possible. Tile drainage may be profitable if cultivated crops are to be grown, but tile are not usually necessary when land is largely used for grass and hay or even small grain. The somewhat unsatisfactory drainage of this land makes it less well adapted to corn, potatoes and other crops sensitive to frost or requiring cultivation.

Over a portion of this type of soil the underlying rock is sandstone rather than granite. This applies especially to something over twenty square miles in the southeastern corner of Clark county and an area about five miles southeast of Greenwood. The presence of this sandstone which gives rise to some sandiness in the sub-soil also improves drainage conditions considerably.

Where the level phase of this silt loam soil with tight sub-soil occurs in large tracts, the lack of drainage is more serious and those purchasing it should include in the estimates of cost of developement the digging of such ditches as may be necessary to remove surface water and probably for its fullest agricultural development, the expense of tiling will be involved. Some tracts of this land are of a marshy character, forming small grass meadows along streams, but in most cases the muck or peat of this soil is not deep and the vegetable matter it contains will improve the fertility of the soil after drainage.

By the use of systems of farming to which it is adapted a large part of this type of land will undoubtedly develop into valuable farms. When only portions of farms consist of this level phase and the remainder is higher or rolling, the lower portions can be used as pasture and hay land, while the upper portions are used for corn and other cultivated crops in such a way that the farm as a whole will be highly developed.

CHAPTER IX.

SILT LOAMS ON LIMESTONE

In the southwestern part of upper Wisconsin, including St. Croix, Pierce, Dunn, Eau Claire, and Chippewa counties, there are considerably areas of silt loam soil underlaid by limestone rocks from which the soils were largely derived or formed. Part of this section was covered by the ice of glacial times and this had the effect of grinding up some of the limestone rock and mixing it with the surface soil originally there and also of filling up the valleys and rounding off the hills; so that the surface is now gently undulating to rolling. Of this area which was covered by the ice, a portion has since been largely prairie with only sparse forest growth while another portion was quite heavily timbered. The prairie portion has somewhat darker soils coming from the vegetable matter of the fine roots of grasses while in the timbered portions the soils are lighter in color. This difference in organic matter, however, is not large. The other part of this limestone region was not covered by the ice of glacial times. This part makes up the unglacial silt loam soils on limestone. It has the deep valleys and steep slopes produced by long periods of stream erosion, and the surface soil has been constantly leached of its lime; so that it now contains much less lime than the soil over which the ice passed. There are, therefore, three sub-divisions of this area of soils underlaid by limestone rocks: (1), Prairie glaciated group; (2), Timbered glaciated group; and (3), Unglaciated group.

ROLLING PRAIRIE SILT LOAM ON LIMESTONE

This soil covers about 200 sq. miles in western St. Croix county. This region is partly quite level, but portions of it are gently undulating with long gentle slopes. Some groves of trees chiefly of oak, maple, basswood and other hardwoods, with a few pine, were scattered over this section, but for the most part, it was a prairie region when first settled.

Value and Uses. This region is one of a very high degree of fertility, adapted to grain and stock raising and is already fully developed. Prices of land are correspondingly high. The amount of organic matter in these soils is not so large as in the typical prairie sections of Illinois and Iowa, but it is enough to give the soil a distinct character. The soil is a good silt loam heavy enough to grow the best pasture grass, and to be well adapted to small grains; while its location in the state, and its good supply of organic matter makes it well adapted to corn.

Improving and Fertilizing. Some tracts of this land can be improved by drainage. The subsoil of some portions is rather retentive of moisture, and for the fullest development, a limited amount of tiling would be helpful. While the soil of this section was at first very fertile, some of it has been cropped a good many years to small grain and hay, much of which has been sold. This has had the effect of reducing the available phosphorus so that the use of phosphate fertilizers in connection with stable manure will greatly increase yields of crops. The cultivation of the land for many years has also resulted in the leaching out of a good deal of the lime in patches over this section and an application of ground limestone or other forms of lime will also be helpful, especially for crops such as alfalfa, peas, beets, etc., which draw heavily on the lime of the soil.

GLACIATED SILT LOAMS ON LIMESTONE

These soils occupy a large tract of land in eastern St. Croix and northern Pierce county. This section was passed over by the ice during glacial times, after which it was quite heavily timbered. It has a gently undulating surface, and rather brownish gray colored soils of a fairly heavy silt loam texture.

Value and Uses. These lands are very fertile and adapted to a wide range of corps including small grains, grasses for hay and pasture and corn. It is already fully developed and rapidly becoming one of the richest sections of the state. The soil of this section has a good supply of lime, except in patches here and there where leaching during a number of years of cultivation has reduced it. On these tracts, lime would be beneficial for crops requiring a good deal of this substance and the use of phosphate fertilizers with stable manure will also be helpful.

Need for Tiling and Liming. While there is almost no marsh land in this region, there are a good many sections where the land is nearly level and the subsoil rather heavy so that underdrainage is not rapid enough during wet seasons. For these sections tiling would be a very great improvement. With the improvements that could be affected by the use of lime, phosphate, and tile drainage, the soil of this region, although already very productive, can be made still more productive.

UNGLACIATED SILT LOAMS ON LIMESTONE

There are several areas of soils derived from limestone in Pierce, Dunn, Eau Claire and Chippewa counties. These regions have deep valleys with rather steep slopes, giving them a rather rough surface, although many tracts of upland between the streams are moderately level or undulating.

Value and Uses. The soil of this regeion while of fairly heavy texture and originally of good degree of fertility, is less well supplied with lime and the hillsides are more subject to washing and leaching by which their fertility is lessened. These factors should be taken into account in choosing lines of farming and in selecting means for improvement. The texture of the soil is well adapted to grass both for pasture and hay, and keeping the steeper slopes under pasture or meadow greatly reduces the surface wash. These regions are, therefore, especially suited, to stock raising in which pasturage is extensively used, while small grain and corn for winter feed are grown on the more level portions of the land.

Fertilizing and Improving. Since the soil of these sections was formed by the weathering of the limestone rocks during very long periods of time, the lime has been largely removed by leaching and a good deal of the soil is more or less sour or acid. The highest fertility can therefore only be reached on these lands through the application of ground limestone, or other forms of lime, especially for crops requiring a good deal of these substances, such as alfalfa, clover, peas, beets, etc., but other crops will also be benefited by its use. An increase in the organic matter through the use of stable manure, green manuring crops, and the plowing under of stubble, straw, or other roughage is also important and the use of some form of phosphate fertilizer will still further increase their fertility.

These lands are already entirely occupied by farms, but a very considerable increase in their productivity can be produced by the application of methods above suggested.

CHAPTER X.

HEAVY RED CLAY

A broad belt of heavy red clay occupying about 1,000,000 acres extends along the south shore of Lake Superior. Small areas of the same soil occur in Burnett county, also in southeastern Shawano county. The country on the south shore of Lake Superior occupied by this soil is a plain gradually rising from the lake, sloping at the rate of thirty to thirty-five feet to the mile. Rather deep ravines and stream valleys have cut their way back into the plain from the lake making areas of steep or hilly topography in places. The sides of these ravines and valleys have good drainage while some portions of the land between these channels are somewhat poorly drained. Shallow depressions or pot holes are occasionally found, but for the most part, there is sufficient slope to permit good surface drainage on this type of soil.

Most of this soil originally bore a heavy growth of White and Norway pine, together with birch and some hemlock. After the pine timber had been cut a thick growth of poplar, White birch, balsam and willow brush took its place. Large areas of this soil have been so frequently burned over that only very small brush or poplar and birch trees remain so that on these areas the clearing is not especially difficult. On some tracts the later growth of birch and poplar are quite thick, making clearing more expensive.

Value and Uses. The fine texture of this soil makes it especially adapted to small grains and grass as hay for pasture. Wheat, barley and oats on well managed farms of this soil produce very high yields of exceptionally good quality of grain. Field peas, clover, timothy, and other grasses grow unusually well. On account of the heavy character of the soil which makes tillage and the development of good tilth difficult during wet seasons this land is not so well adapted to corn or other cultivated crops as are somewhat lighter soils. Hardy root crops should be substituted largely for corn or stock feed. The nearness to the lake keeps the temperature somewhat lower during the growing season which is also a disadvantage for corn. If, after two or three crops of clover have been grown, care is taken not to plow and cultivate this land when it is too wet, the mechanical condition of the soil becomes very much better, and corn and other cultivated crops can be grown more successfully, especially on tracts which have good slope.

Tiling and Fertilizing. Tile drainage is very successful on this class of soil and will prove one of the chief improvements which can be made in it. This soil is usually not acid, though occasionally patches of acid soil are found. The amount of organic matter, or humus varies a good deal. The slight depressions scattered over the surface usually contain a shallow muck, giving the soil considerable organic matter, though in general, the soil is not high in humus and an effort should be made to increase this through the use of stable manure and green manuring crops. Besides organic matter and nitrogen, the only element at all lacking as plant food is phosphorus. The amount of this element in this soil is somewhat less than in other classes of clay soils and the use of some form of phosphate fertilizer in addition to stable manure will in the long run be found beneficial, though its use is not necessary in order to secure good yields for several years after breaking.

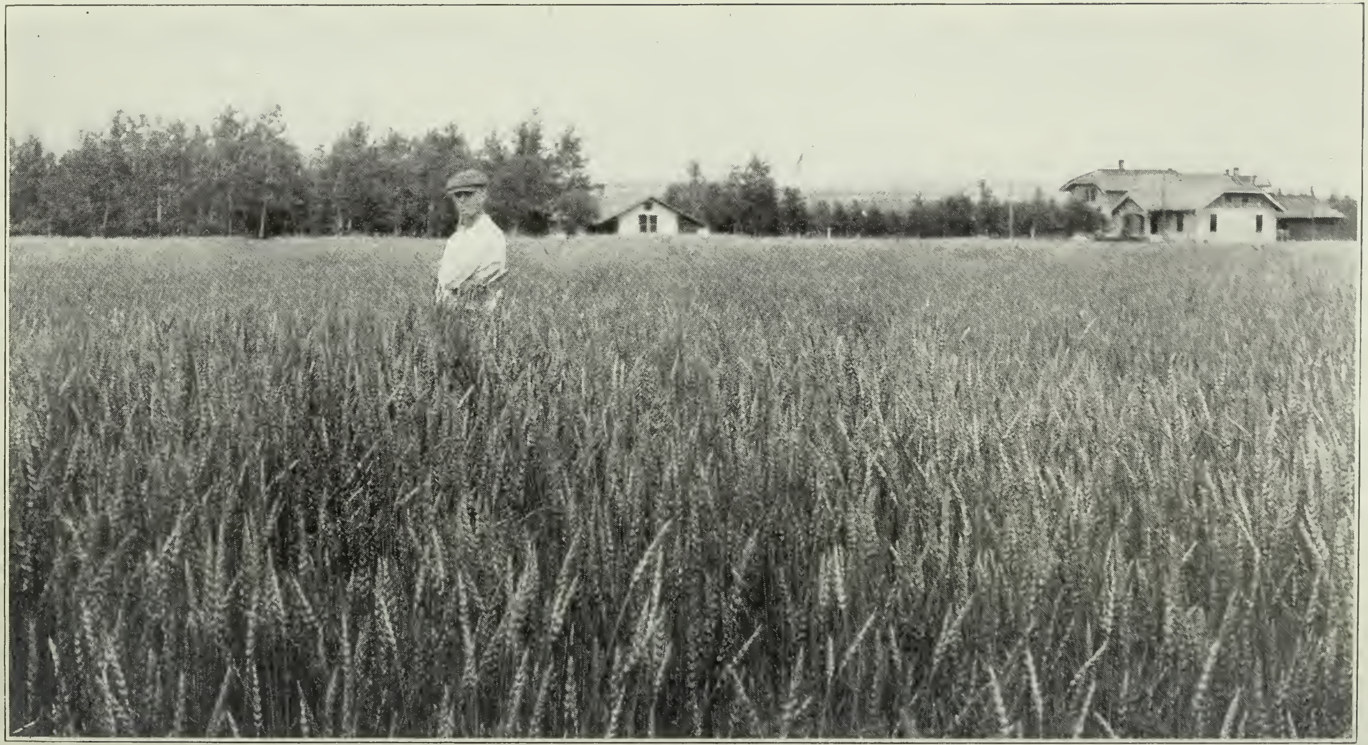

FIG. 6.—WHEAT ON HEAVY RED CLAY AT ASHLAND SUB-STATION FARM

There are 1,000,000 acres of this soil along the south shores of Lake Superior. This soil produces heavy yields of wheat, barley and oats. Field peas, clover, timothy and other grasses do unusually well.

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CHAPTER XI.

POORLY DRAINED SOILS

This group of soils includes bottom land along streams and along the borders of marshes where the lack of good underdrainage frequently extends for some distance beyond the marsh proper. The meadow lands along streams are mostly subject to overflow during high water, but even where not overflowed the drainage is not sufficient for good cultivation. A few small additional tracts are included with these soils and shown on the map as poorly drained lands, which are so situated that they receive spring or seepage water from above, making the subsoil too wet for cultivation.

Most of these soils would be available for farming if they were underdrained. Part of them are so situated that they cannot be readily and economically drained as in the case of those lying along streams and subject to overflow at high water which would require very considerable expense for diking to prevent the overflow.

It has not been found practicable to subdivide these poorly drained soils into as many classes with reference to texture or fineness of grain as in the case of upland soils and they have been simply divided into (1) poorly drained sandy soil and (2) poorly drained heavier soils.

POORLY DRAINED SANDY SOILS

Poorly drained sandy soils include strips of land along the borders of the marshes in sandy sections. They are mostly covered with a growth of hemlock, cedar, birch, etc., but there are frequent patches of open meadow bearing blue-joint and other marsh grasses. The soil is usually quite dark or black in color from the organic or vegetable matter they contain although this vegetable matter does not constitute more than ten to fifteen per cent of the weight of the soil, and they cannot, therefore, be called muck or peat.

Improving and Fertilizing. Drainage should be the first step in the improvement of these soils; though much of it can be used for crops which will stand considerable water, such as red top, and blue joint, or even timothy and alsike clover for hay and pasture. Any further use for farming purposes would require drainage. Most of these soils are also somewhat acid and will be benefited by liming, and by the use of some fertilizers containing phosphorus, unless stable manure is available. After clearing, this treatment will add greatly to the value even of the pasture.

POORLY DRAINED HEAVY SOILS

This group includes wet lands lying along the borders of marshes and along streams, such as loams and silt loams with generally heavy subsoils. Most of this land was covered by a growth of trees including soft maple, elm, cedar, black ash and birch.

Value and Use. The agricultural use of this land in its present condition is quite variable. Most of it can be developed into very good pasturage after clearing and seeding in of the right grasses. Land of this kind should be divided up with higher land so that it can be used as pasture while the higher land is used for other crops.

Drainage Needed for Full Use. Where this land is so situated that it can be drained either by good ditches or by tiling, practically all of it is capable of development into very good farm land. This is particularly true of portions of this land in Marathon, Clark, Taylor and Lincoln counties.

CHAPTER XII.

PEAT AND MUCK

Marshes of considerable extent occur scattered over a large part of the northern portion of the state. These have been largely formed by the gradual filling up of shallow lakes left at the close of the ice epoch. Sphagnum moss and other water plants growing in these lakes and settling to the bottom gradually filled them up, leaving the deposit of peat. Where sediment from upland washed in it formed muck. The vegetable matter of these peat and muck soils varies in depth from a few inches to as much as 10 ft. or 12 ft. The most common depth is between 2 and 5 ft.

Drainage Needed for Development. Two factors influence the cost of reclaiming these marsh lands for agricultural use: (1), the readiness with which good drainage can be secured, and (2), the expense of clearing and breaking. When the land exists in large tracts, the organization of drainage districts will usually be necessary in order to secure sufficient outlet. The distance and amount of ditching necessary to secure this outlet ditch, and the co-operation of all land owners concerned must be considered. Then again when the marsh land is covered with a heavy growth of tamarack, spruce or other trees, the labor of clearing is of course very much larger than in the case of open grass marshes.

Thorough drainage of these lands, which will make possible the growth of other crops than simply pasture or hay grasses, usually requires that ditches or still better tile be put in from six to ten rods apart and costing under ordinary conditions from $15 to $25 per acre.

Handling and Fertilizing. In addition to good drainage, these muck and peat lands are found to require fertilizers containing phosphorus and potash to maintain their fertility. They are very high in nitrogen, a plant food which occurs in the organic matter. Fertilizers containing phosphorus and potash will ordinarily give as good results as will heavy applications of stable manure so that on farms including upland as well as marsh land, the stable manure should be used on the upland and phosphate and potash fertilizers purchased for the marsh land. In addition to proper fertilization these lands are usually open and loose in character and are greatly benefited by the use of a heavy roller to compact the soil. Pasturing for two or three years where this is practicable effects the same improvement.

The use of lime in some form is very frequently necessary in addition to the other fertilizers mentioned. This is particularly true in the case of very raw peat marshes, especially in the northern part of this section, and it is probable that the use of lime, or ground limestone, or marl, at the rate of 1 to 2 tons per acre for the first application followed by about ½ ton every 3 to 5 years will be found profitable very generally.

Crops for Marsh Land. When well drained, properly fertilized and managed, these marsh lands can be made to produce heavy yields of the crops to which they are adapted. Among these crops are certain special crops such as cabbage, celery and onions, but of course the larger portions must be used for staple crops including buckwheat, grasses for hay and pasture, especially timothy and alsike clover, hardy root crops and some small grains, especially rye. These lands are more subject to frost than upland and so are less adapted to tender crops, such as corn or potatoes.

CHAPTER XIII.

ROUGH OR VERY STONY LAND

There is considerable land in northern Wisconsin which is so rough and hilly as to make the use of agricultural machinery impracticable and it is, therefore, unsuited to agricultural use. Most of the land of this character occurs in tracts of considerable size. There is, however, quite a little rough land scattered through the other types of soil in small areas which it was impracticable to indicate separately on the map. Moreover, when this rough land occurs in small tracts it can be divided up with good land adjacent in such a way that it can be used as pasture or wood-lot to good advantage. But when rough land occupies tracts three or four square miles or more in extent, it is impossible to divide it up into farms on which there will be a sufficient amount of good tillable land. Two phases of this rough and hilly land are shown on the map.

Sandy Soil. This phase is not only very rolling, or rough and stony, but the soil is so sandy as not to be able to support even a fair pasture grass. Rock outcrop and rough stony land is included where bed rock or ledge rocks outcrop so frequently that the shallow soil cover cannot well be cultivated.

Value and Uses. This class of land could be used for woodlots or forestry purposes, and this is the only extensive use to which they are adapted. This land occurs extensively in Bayfield, Sawyer, Vilas, Oneida, and Forest counties and to less extent in several other counties. It is of course true that there are some small tracts as large as forty acres in extent that are sufficiently smooth to permit cultivation, associated with this rough land, but it has been impracticable to separate these in the work of the Survey in this part of the state and even if the small tracts were separate, it would be undesirable for settlers to locate on these tracts scattered infrequently through larger areas which would not be suitable for agricultural use since they would be very much isolated and have poor schools, and other disadvantages. It is to be hoped that these large tracts of rough sandy land will be developed for forestry purposes by either the state or by private interests.

Heavy Soil. The other class of rough lands has a sufficiently heavy soil to carry at least a fair pasture grass through ordinary seasons and so is suitable for grazing. Land of this character occurs in considerable tracts in Taylor, Lincoln, Oneida, Vilas, Price, Rusk and some other counties. Much of this land is not only too rough for cultivation, but is very stony.

Value and Uses. It would be suitable for grazing on a large scale. It is of course true that there are some small tracts of comparatively good land which could be cultivated scattered through this rough land, but there is too small an amount of it to raise the feed necessary for winter feeding of stock which would pasture on the rough land. It would be necessary, therefore, either to take stock to other sections for winter feeding or to haul feed to these sections which could be used for grazing.

Clearing for Pasture. The proper clearing of this land for pasture purposes is a matter which would require considerable care. The pasturage on the uncleared brush land is of course very poor and it would be necessary to ''brush'' the land and seed in grasses in order to secure good pasturage. Such land would have a very considerable value for this purpose. The gross returns are of course small in comparison with those from cultivated land, but the expense of management is also very small so that the net profit is very considerable. Northern Wisconsin is especially adapted to grazing because it has comparatively cool summers and an excellent rainfall. The rainfall during the six months from the first of May till the first of November is about 18 inches and is ordinarily very well distributed through this period. Moreover, the heavy snows which usually occur in the northern part of the state act as a protection to the grasses through the winter and are absorbed gradually in the spring giving the soil a sufficient amount of moisture to penetrate several feet into the subsoil. While pasturage is usually not good until about the middle of May, it ordinarily continues good late in the fall so that the pasture period is seldom less than six months.

HOW TO USE THE MAP

The location or description of a tract of land is usually given by Section, Township, Range, thus: Sec. 10, T. 35 N, R 5 E. This map is so drawn that one inch on the map means six (6) miles on the ground, and it is divided by dotted lines into squares one inch on each side. These squares are Civil Townships. The townships are numbered from the bottom of the map UP, beginning with Township 25 North. The number of the Range (R 5 E, or R 5 W) shows how many squares the township is east or west of the Fourth Principal Meridian. The Fourth Principal Meridian runs north and south just west of Phillips in Price County. To make locating easy, the Ranges are numbered across the bottom of the map and along an east and west line just north of Park Falls in Price County. The township numbers are put along the sides of the map, and on the Fourth Principal Meridian.

A Correction Line running across the map from Marinette to New Richmond causes an offset in the Range Lines between Townships 30 and 31 N. For locations north of this correction line use the Range numbers (II, V, X, etc.) found along the east and west line just north of Park Falls.

Each township is divided into 36 sections. They are numbered beginning at the upper right hand corner and running west to No. 6. Section 7 is immediately south of section 6, and 12 immediately south of 1, 13 south of 12, and so on.

ACKNOWLEDGEMENTS

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APPENDIX I.

The foregoing pages are based on the reconnoissance survey of the northern half of the state on which five reports have been published as follows:

1. South Part of Northwest Wisconsin.
2. North Part of Northwest Wisconsin.
3. Northeastern Wisconsin.
4. North Part of North Central Wisconsin.
5. South Part of North Central Wisconsin.

It also includes the detailed survey of Door County and the northern tier of towns in Kewaunee, Brown, Waupaca, Portage, Wood and Clark counties.

The types described in these reports have been grouped in the present report as shown in the following list:

SANDS

Level Sands
    Plainfield Sand
    Beach Sand
    Sterling Sand
    Plainfield Gravelly Sand.

Undulating Sands
    Vilas Sand
    Coloma Sand
    Gloucester Sand

LIGHT SANDY LOAMS

Level Light Sandy Loams
    Plainfield Fine Sand
    Plainfield Sandy Loam
    Superior Fine Sand
    Meridian Sandy Loam
    Thornapple Sandy Loam
    Chetek Sandy Loam

ndulating Light Sandy Loams
Vilas Fine Sand
Vilas Sandy Loam and Rolling Phase
Coloma Fine Sandy (Auburn Sandy Loam- part)
Coloma Sandy Loam
Marathon Sandy Loam
Boone fine Sand.

Heavy Sandy Loams

evel Heavy Sandy Loams
Antigo Fine Sandy Loam
Superior Fine Sandy Loam, Level Phase
Rice Lake Loam (part)
Fox Fine Sandy Loam
Superior Loam (Iron and Burnett Counties)

olling Heavy Sandy Loams
Kennan Fine Sandy Loam
Kennan Loam, Rolling Phase
Mellen Fine Sandy Loam and Rolling Phase
Mellen Loam and Rolling Phase
Boone Fine Sandy Loam
Auburn Loams
Marathon Fine Sandy Loam
Superior Loam (Burnett County)
Superior Fine Sandy Loam
Superior Sandy Loam
Chelsea Loam

alcareous Heavy Sandy Loams
Miami Fine Sandy Loam and Poorly Drained Phase
Miami Loams
Cushing Loams

Silt Loams With Well-Drained Subsoils

evel Silt Loams With Well-Drained Subsoil
Antigo Silt Loam
Milltown Silt Loam
Rice Lake Loams, Silt Loam Phase

evel Prairie Silt Loams with Well-Drained Subsoil.
Rice Lake Loam (part)

Rolling Silt Loams with Well-Drained Subsoil

- Kennan Silt Loam and Rolling Phase
- Mellen Silt Loam and Rolling Phase
- Marathon Silt Loam
- Marathon Gravelly Silt Loam

SILT LOAMS WITH HEAVY SUBSOILS

Level Silt Loams with Tight Subsoil

- Colby Silt Loam, Level Phase
- Colby Loam
- Vesper Silt Loam
- Webster Loam, Clay Loam Phase

Rolling Silt Loams with Heavy Subsoil

- Colby Silt Loam, Rolling Phase
- Superior Loam
- Superior Loam, Rolling Phase

SILT LOAMS ON LIMESTONE

Rolling Prairie Silt Loams on Limestone

- Part of Baldwin Silt Loam

Unglaciated Silt Loams on Limestone

- Knox silt loam

Glaciated Silt Loams on Limestone

- Miami Silt Loam
- Baldwin Silt Loam

HEAVY RED CLAY

Clays and Clay Loams

- Superior Clay Loam and Rolling Phase
- Superior Clay

POORLY DRAINED SOILS

Sandy

- Dunning Fine Sand
- Plainfield Fine Sand, Poorly Drained Phase
- Genesee Sand
- Genesse Sandy Loam

eavy

Whitman Silt Loam
Meadow
Genesse Loam
Genesee Silt Loam
Poygan Fine Sandy Loam
Clyde Loam
Vesper Fine Sandy Loam
Colby Fine Sandy Loam

PEAT AND MUCK

wamp and Marsh

ROUGH OR VERY STONY LAND

andy Soil

Vilas Sand
Vilas Stony Sand
Vilas Gravelly Sandy Loam
Rock Outcrop
Rough Stony Land

eavier Soil

Kennan Fine Sandy Loam, Rough Phase
Vilas Sandy Loam, Rolling Phase
Iron range, Copper range, Rib Hill, rough areas in Kennan Silt Loam and Chelsea Loam, etc.

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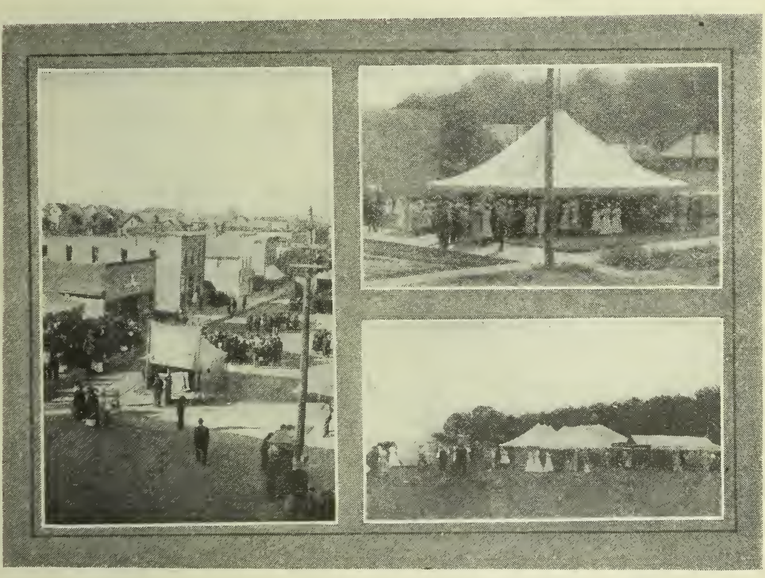
The Rural Community Fair

C. J. GALPIN and EMILY F. HOAG



MEET US AT THE COMMUNITY FAIR

If the town is the neighborhood center, the streets will gladly be given up for the fair. Don't forget the merry-go-round for the children.

AGRICULTURAL EXPERIMENT STATION OF
THE UNIVERSITY OF WISCONSIN

MADISON

DIGEST

The community fair awakens the community pride, spirit, and life. It includes every person in the neighborhood and every organization or business there. It is a day on which the whole countryside plays and renews acquaintanceship. Pages 3 to 6.

It may be promoted by the town, the school, a merchant, a farmer's organization, a neighborhood club, church, or high-school, the county or township or other organization. The organization, the raising of the money, the location of the fair, appointment of committees, and other duties vary with the community and with the fair. Pages 16 to 18.

Advertising the fair is an essential and important duty. The newspaper men gladly cooperate. Various types of publicity material such as slogans, a calendar, premium list, booklet, or poster, as well as newspaper advertising, may be used effectively. Pages 18 to 27.

To produce and stage the fair requires careful thought and hard work on the part of the committees in charge. Committees on arrangement, on special contests, exhibits, entertainment, and other lines of activity must be appointed. Subcommittees are also effective in efficient management. Pages 38 to 43.

Priles and awards must be handled fairly, and the committees having them in charge must use judgment and discrimination. Cash prizes do not have to be given. Medals, ribbons, cups, or trade prizes may be used. Pages 43 to 44.

The fair should result in a better community. Well organized, efficiently managed, with the community interests at heart, the fair will be a community asset. Pages 44 to 49

The Rural Community Fair

In the fall of each year the farmers of Wisconsin throw on the screen before the public a great moving picture of their year's activities. Thousands of accurate photographs of the country at its best go into the making of this picture. The state fair provides the spectacular, breath-taking interludes in the picture; the county fairs contribute the big crowd activities; the small community fairs supply that element without which any film picture is incomplete, for they give to the fall festival picture the intimate touch, the ''close-up'' on the farmers' products, ambitions, and victories.

Although these ''close-up'' fairs may include but one or two neighborhoods, yet we find that, throughout Wisconsin, they are usually as excellent and painstaking in workmanship as are the great county exhibits which represent dozens of communities. As a matter of fact, there is a peculiar inspiration about staging a community fair that can not, in the nature of things, be experienced in the organization of a larger exhibit.

In the small community fair, neighbor works with neighbor; the home-grown products are seen in a new light; every contestant is known to every other contestant as well as to all the spectators. The conditions and circumstances under which all the products are made or grown are known to all the participants; a special pride is taken in every prize-winning entry by the whole community.

At first thought, it may possibly seem that the community fairs, although well enough in themselves, may prove somewhat detrimental to the success of the county fairs of the state. We find, however, that there is no need for any such fear. On the contrary, it appears that the community fairs are fast becoming a force in rejuvenating the county fairs.

At the community fairs, which are frequently held a little earlier in the fall than the county fairs, the people of a community or neighborhood discover their strongest points, their best exhibits, and are eager to take them where they may be compared with similar exhibits from other communities.

Neighborhoods, communities, school districts, and farmers' clubs have got in the habit of making an entry of special booths of their best products at the county fair. In some cases, as at the Walworth County Fair, a farmers' club contest with as many as nine or ten clubs competing in exhibits has become an annual feature which provides competition as keen as that provided by the old-time county fair horse races.

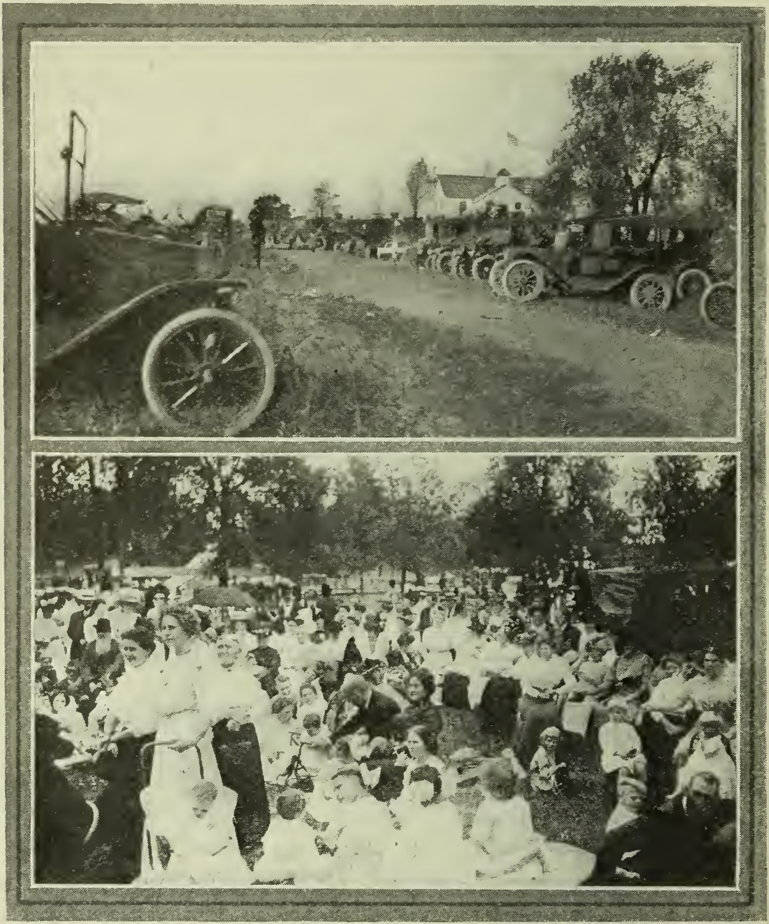


FIG. 1.—CROWDS COME FROM FAR AND NEAR

People will come a long way to attend a worthwhile fair. It does not pay to be satisfied with anything but the best.

The community standardizes its products. A community should not hesitate to give a fair for fear the result will be inferior in some respects. It is necessary, in fact, to make at least one or two trials to find out just where the best material for building up the fair may be found. The first year it may be found impossible to call for exhibits in certain standard breeds of seeds or animals. A few specimens of the best of these may, however, be on exhibit. A discussion of the valued points may follow and it is likely that, in the following year, the sentiment of the community may be turned towards the production of certain standard varieties of potatoes, poultry, pigs, and calves.

In this fashion the community fair gradually enables a community to build up for itself a reputation for certain lines of products, and this in time may lead to standardization of packing, shipping and selling.

The community fair leaves out no one. There is no member of the community left out of the community fair. Everyone is included from the youngest, who figure in the better babies contest, to the oldest, who have in their charge the cherished historic relics. No interest in the community is omitted from the community fair program. The local paper, the school, the church, the clubs, the choral union, the dramatic class, the junior gardeners, the boy scouts, all have a place in this community event.

The fair blazes new trails. It gets all kinds of people working together in new relationships. New abilities are discovered, talent is developed, and best of all, people learn new ways and means of cooperating. Wherever the good community fair has left its footprints, flowers of social cooperation are likely to spring up as memorials to this working-together festival.

The fair is a community booster. When a community gives a fair, it advertises itself. Through the paper, the posters, the talks, and through the exhibit at the fair itself, the best kind of community advertising is obtained each year. The community gets known as a fine place for farming, a splendid place in which to have a home, and a good place to go for worthwhile ideas, products, and men.

The fair is an exchange center. Everyone who shares in giving a community fair is bound to learn a great deal in the course of his efforts. He trades ideas with all his neighbors and goes home richer in thought. He discovers where the best seed, the finest eggs in the neighborhood may be obtained. He finds what farmers are in need of his kind of purebred stock. He gets to know and understand his town neighbors also, if the fair is given at the trade center. His town neighbor gets to know him, too, and mutual respect is bound to result.

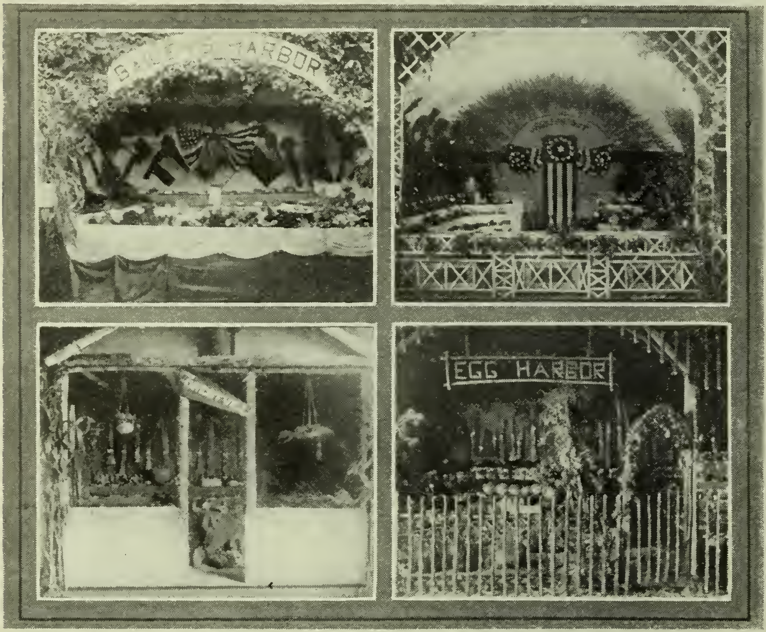


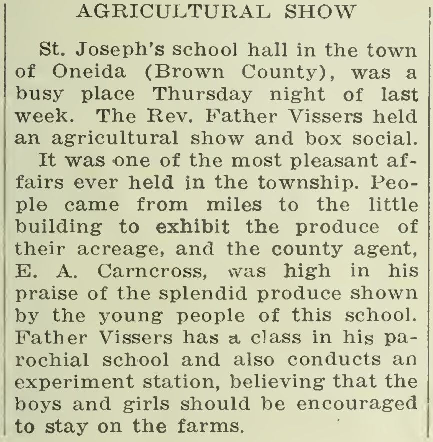
FIG. 2.—COMMUNITY BOOTHS AT THE COUNTY FAIR

As a result of the local community picnic or fair, booths or exhibits are often sent to the county or state fair.

The farmer and his family are too likely to see their surroundings and their neighbors only in the guise of serious labor. The community fair breaks up this monotonous outlook and presents for their consideration a thousand new kaleidoscopic glimpses of this same neighborhood life. A community fair, rightly conducted, is equivalent to a month's vacation.

HOW TO PLAN AND ORGANIZE THE FAIR

Agencies for promoting a fair. There are various ways in which a fair may be started. It may start as the very modest effort of one socially minded individual. This clipping from a country paper gives an account of a community fair started and managed by a local priest:

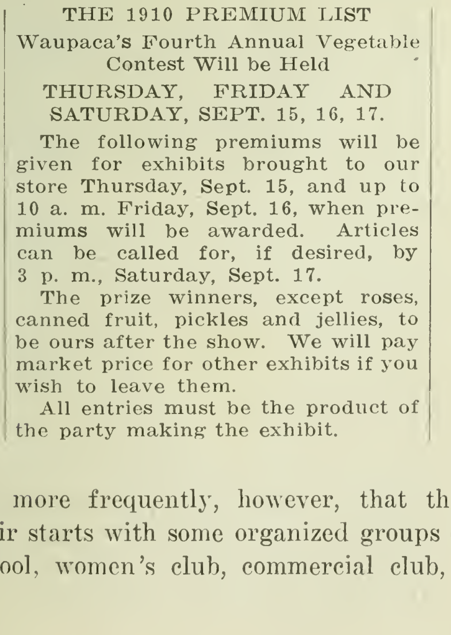


AGRICULTURAL SHOW

St. Joseph's school hall in the town of Oneida (Brown County), was a busy place Thursday night of last week. The Rev. Father Vissers held an agricultural show and box social.

It was one of the most pleasant affairs ever held in the township. People came from miles to the little building to exhibit the produce of their acreage, and the county agent, E. A. Carncross, was high in his praise of the splendid produce shown by the young people of this school. Father Vissers has a class in his parochial school and also conducts an experiment station, believing that the boys and girls should be encouraged to stay on the farms.

How a fair may be successfully featured as a part of a small town merchant's policy is shown in part by the following premium list, put out by Mr. Cristy of Waupaca.



THE 1910 PREMIUM LIST

Waupaca's Fourth Annual Vegetable Contest Will be Held

THURSDAY, FRIDAY AND SATURDAY, SEPT. 15, 16, 17.

The following premiums will be given for exhibits brought to our store Thursday, Sept. 15, and up to 10 a. m. Friday, Sept. 16, when premiums will be awarded. Articles can be called for, if desired, by 3 p. m., Saturday, Sept. 17.

The prize winners, except roses, canned fruit, pickles and jellies, to be ours after the show. We will pay market price for other exhibits if you wish to leave them.

All entries must be the product of the party making the exhibit.

It happens more frequently, however, that the idea of a community fair starts with some organized groups of people, as a church, school, women's club, commercial club, or farmers' club.

Here is a short account of a fair organized by the La Grange Farmers' Club of Walworth County.

> The Farmers' Club Fair in the community hall and sheds last Wednesday was a decided success and was well attended, both day and evening. There was a good display of vegetables, bread, cookies, cakes, etc., also sheep, chickens, calves, and ponies. About $78 in premiums were given to the children, while the men received ribbons for the kinds of grains, besides corn. Mr. Bewick of Madison was the speaker in the evening. We are hoping for a bigger and better fair next year.

This account shows how the Port Edwards (Wood County) Improvement Society, the local women's club, and the Nekoosa-Edwards Paper Mill worked together in the organization of a community fair which produced good results.

> The Port Edwards Improvement Association was organized in the spring of 1915 for the purpose outlined in the enclosed copy of by-laws.
>
> The different committees worked during the summer months and prepared everybody and everything for the combined flower and vegetable show held at the schoolhouse in September of that year under the auspices of the Ladies' Club.
>
> In 1916 we worked along the same lines but the early frost spoiled our gardens so the annual show could not be held.
>
> In the spring of 1917 this association with the help of the Nekoosa-Edwards Paper Company started a drive to assist the people of this village in raising vegetables.
>
> The paper company turned over the land plowed and prepared for planting free of charge and furnished seed at cost, and in two cases, free.
>
> The individual lots were 60 by 150 feet, and about 70 families applied for land. The improvement association had charge of the allotment and prepared a map of the village, showing the different locations with the names of the occupants. This map was placed in the post office for public information and was kept there

all summer in case any disputes should arise.

This year we encouraged the raising of potatoes and garden truck land did not offer any prizes for flowers.

It was very gratifying to notice the number of pretty flowers which were raised in the village in spite of this, and which were brought in for decoration at the fall show.

During the summer the committees watched the lots and the village gardener assisted everybody with advice as to what and where to plant.

The fair was advertised by handbills and held at the schoolhouse. The ladies of the S. & R. Club assisted by the teachers, took charge of the decorations and arrangements of the exhibit. There were 276 individual exhibits and 34 different kinds of vegetables in the competition. The judges were from Nekoosa and Grand Rapids, and the Nekoosa-Edwards Paper Company put up $225 in cash prizes which were given out at the public entertainment the same night.

We had about 2,000 visitors from the village and vicinity.

We hope to be able to hold similar competitions and fairs every year as we have found that they have had a marked influence on the civic pride of our village people. This last summer, in addition to having one of the cleanest and neatest villages in the state, we raised enough potatoes and vegetables to last us until next year.

A great many rural schools and country high-schools, in all parts of Wisconsin, yearly hold fairs in which whole communities or neighborhoods participate. An account written by a rural teacher gives a fairly good idea of the nature of a fair organized by a small rural school.

RURAL SCHOOL FAIR IN BARABOO COMMUNITY (SAUK COUNTY)—1917

For the last three years we have held a school fair in the fall and I shall attempt to tell you the most helpful parts of each.

People in the community are beginning to speak of the event as something of certainty, as they do of the county fair. This is encouragement in itself, as it manifests interest.

The fair was held to interest the pupils in the selection of fruits, vegetables, corn and potatoes, also to encourage neater school work; e. g., composition, maps, drawings.

The pupils made a pumpkin invitation for every home in the district. Notices of the event were sent to the local newspapers and some of the pupils used our large type and printed a sign which they posted at the crossroads.

One year we charged 10 cents admission, another we sold the baking and sewing, while some of the pupils had a wild man's cage, others a fat lady show, others a fortune teller's tent, and others a rag doll throw with the prize an apple. These attractions were held in the basement of the building, each costing 1 cent and affording a great deal of amusement.

The eighth grade was divided and each had a department to superintend with the privilege of calling upon others to help. The teachers acted as a "walking encyclopedia" to answer all troublesome questions during this time.

The pupils of the lower grades brought leaves, flags, and corn for decorations.

The school work was judged by one of the county supervisors, fruits and vegetables by the principal of the county training school, and cooking and sewing by a competent woman from outside the district.

Our work was arranged in departments, department I being school work; department II, cooking; department III, sewing; department IV, fruits and vegetables; and department V, largest fruits and vegetables. Each pupil had a number and all exhibits were tagged thus:

Dept. I
Best Map
Sauk
County
Pupil's Number ....No. 16

This made judging fair.

The material was arranged by the superintendents of the various departments.

No money prizes were offered.

A blue ribbon signified first prize, a red one, second. It hardly seems to me the proper thing to offer money as prizes at these district fairs, as the fair itself is to teach the pupil to take a greater interest in the larger exhibit at the county fair and there win money. A ribbon means as much or more to our pupils as money does to those who exhibit at the large fairs. We offered a prize of a book to the pupil receiving the greatest number of blue and red ribbons. This caused some rivalry.

When admission was charged we cleared about $13. We paid for ribbons, prize and a few other expenses and then the money for necessary school material, being careful to render an account to the school board.

The most successful feature of these fairs is the spirit of cooperation gained between pupil, teacher and parent. The pupil becomes interested in the things the parent must work with, thus creating an atmosphere of sympathy for each other's work. After looking at a display of school work, the parent often expresses a desire to see the work as it is carried on in school and very often visits school later in the year. Pupils become deeply interested in the local fairs and note the manner and arrangement of the work, but the greatest success lies in the fact, that although many pupils become rivals for the coveted prize, there is no enmity shown and all are friendly.

It is the wish of all that another fair may be held during the coming year.

One of the best high-school fairs in the state is held each year at Livingston (Grant County). This is a newspaper account of one held recently:

LIVINGSTON HIGH-SCHOOL FAIR

"Could I enter some buckwheat at the fair?" "Do you have to know the name of your pumpkin if you take it to the fair?" "Can I bring my rabbits over?" These are some of the questions which the Livingston boys were asking before the day set for their school fair.

Every year the agricultural high school at Livingston, holds a high-school fair which is a community fair as well. Farmers and breeders from the surrounding country bring their stock, and many of the exhibits would put some of our county fairs to shame. There is no admission charged, the premium money being raised by subscription among the local business men and farmers. Everyone in the community is interested in the event and is behind it.

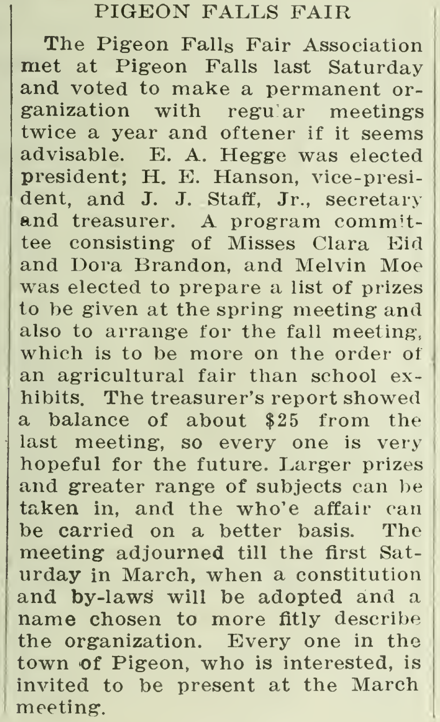
This year one of the interesting features of the fair was a stock judging contest conducted by Professor J. A. James of the agricultural college. High-school judging teams from Dodgeville, Cobb, Montfort, and Livingston competed for a fine, registered Jersey calf. The teams placed the cattle classes and Montfort won the calf, with Livingston a close second. The individual contest for boys under 16 years of age was won by Nagel from the Cobb school.

The usual good display of horses and cattle was in evidence this year, competition being especially strong in some of the horse classes as well as among the dairy breeds. The poultry classes were not so well filled but the quality of those exhibited was outstanding.

One class of exhibits open only to the high-school pupils was that of home project work which had been done in connection with the regular high-school work. Products and reports of the work were shown. First prize in this class went to Will Trankle on his sample of corn, and the second to Miss V. Wilkins on her Jersey calf.

We believe that such a fair as this is the kind that should find a place in more communities throughout the country. Such fairs stimulate local competition between the fathers as well as between the juniors, and the result is a better class of farm stock and a better quality of farming. You other juniors, are you having school fairs this year? If not, why not try to get your teacher interested in it? If you can interest them, possibly you can have one next year. Remember, that you will have to lay your plans this winter or else you won't be ready with a first-class exhibit next fall.

In many rural communities throughout the state the interest in local fairs is so keen that associations are organized for the sole purpose of conducting the fairs from year to year. This clipping gives a description of the origin of the fair association at Pigeon Falls, Trempealeau County, in 1916:



PIGEON FALLS FAIR

The Pigeon Falls Fair Association met at Pigeon Falls last Saturday and voted to make a permanent organization with regular meetings twice a year and oftener if it seems advisable. E. A. Hegge was elected president; H. E. Hanson, vice-president, and J. J. Staff, Jr., secretary and treasurer. A program committee consisting of Misses Clara Eid and Dora Brandon, and Melvin Moe was elected to prepare a list of prizes to be given at the spring meeting and also to arrange for the fall meeting, which is to be more on the order of an agricultural fair than school exhibits. The treasurer's report showed a balance of about $25 from the last meeting, so every one is very hopeful for the future. Larger prizes and greater range of subjects can be taken in, and the whole affair can be carried on a better basis. The meeting adjourned till the first Saturday in March, when a constitution and by-laws will be adopted and a name chosen to more fitly describe the organization. Every one in the town of Pigeon, who is interested, is invited to be present at the March meeting.

Whether the community fair is organized by a club or fair association, it is very essential that all parts of the community in which the fair is held, be well represented on the fair organization committee. In case six neighborhoods combine to produce a community fair, there should be at least six members on the committee, one from each neighborhood.

Obtaining funds for the fair. The funds for the community fair may be obtained in a variety of ways. Each community has its favorite method. In Kiel (Manitowoc County) the money for the annual fair is raised by township tax. At the spring town meeting in 1917 the town appropriated $50 for prizes. In Rio (Columbia County) the money for the fair was obtained by subscription from the business men of the town. This plan works fairly well if the subscriptions are taken up first in a business-like way, and not afterwards, in a begging fashion.

Some committees endeavor to make their fairs self-supporting. The Windsor (Dane County) Fair Association gets out an annual fair premium book in which are advertisements. At the Black Hawk (Sauk County) Fair, expenses were met by the sale of candy and a small admission fee. At Rio an admission charge was made for a home talent play and dance given in connection with the fair. At Juneau (Dodge County), the sale of 300 tickets brought $30, which paid the fair expenses. At the Holcombe (Chippewa County) Fair, a somewhat different arrangement was provided. To quote from one of the organizers:

> We made no charge for entries, nor did we charge for the exhibition. The agricultural building people were met by a man stationed at a desk who requested everyone to register, and if any one so desired, he could give 25 cents, or such a matter, for the benefit of the farmers' club which arranged the fair. In this manner we raised a trifle over $200. When a person registered, he was given a tag which read, "I have registered, have you?"

In some instances money is raised by an auction sale at the close of the fair of the vegetables and fruit products exhibited. Product entrance fees are also sometimes charged.

The following financial statement of the Fourth Annual Market Day of Pepin (Pepin County) may be of value in showing something about the disposal of fair funds:

> We publish herewith the financial statement, of the financial committee, showing the amount of funds handled, the sources from which it was received, and its disposition. The committee finds that, after awarding prizes as liberally as consistent, they still have on hand $16.86 which will be held in a fund for the conduct of a bigger and better Market Day next year.

Treasurer's Statement

Balance on hand	$ 1.51
Merchant's donation	36.00
Exhibits uncalled for	2.95
	$40.46
Advertising	$ 4.25
Incidentals	.25
Cash prizes paid	18.50
Postage	.60
	$23.60
Balance on hand	$16.86

Treasurer.............................

The Westboro (Taylor County) people describe their fair finance arrangements as follows:

> We usually spend a very small amount of money, not more than $15. This year we had at the spring town meeting a resolution passed appropriating $150 by the town and $50 by the schools to put over the consolidated plowing contest and fair. We also took up a small subscription among our merchants to get funds for a lunch. In all we had about $235.
>
> The money we had was spent about as follows:
>
> | | |
> |---|---|
> | Sulky plow for plowing contest | $25 |
> | Buns, butter, etc. | 20 |
> | Moving pictures | 10 |
> | Printing and advertising | 25 |
> | Band | 80 |
> | Lumber-making exhibit cases | 15 |
> | Prizes for school exhibits | 25 |
> | Will give about $25 in addition to purchase a bull for plowing contest | 25 |
>
> We can put over a fine community fair for about $150 another year and expect to give very good prizes. It does a lot of good, we find, in bringing the people of the country to know one another and show them that to live right we must think of each other and get together often.

Location of the fair. The fair is usually held at some central point in the community. Fairs of neighborhood size usually center around the rural school. Larger fairs are generally most successful when held at the trade center where farmers and town business men may enjoy the event together.

In some cases the fair is held in the public square or along the main street of the town. Booths are then arranged in the windows of the stores located along the main street, or in roped-off spaces in the street.

Generally, however, either the fair is held in some building, such as the farm exhibit building, clubhouse, schoolhouse, town hall, or opera house, or the exhibits are placed in tents and open air booths. At times a successful combination of these various methods is effected.

Time for holding the fair. The time for holding the fair is considered by most committees to be some time during late

August or in September or October. In case the fair is held early in September, the community has the advantage of being especially well prepared for exhibiting at the county or state fair. However, it is possible that winter may be the most convenient season for holding a fair in some communities. In such cases, straw rides and winter sports, such as ski tournaments, are features which usually add to the enjoyment of the occasion.

Business of fair committees. It is absolutely essential that a community fair, whatever its size, be thoroughly and completely organized far in advance of its production. It is the guarding against ''last-moment methods,'' ''pick-up'' makeshifts, and second-rate substitutes that makes the community fair an event of dignity and a source of pride to those participating.

The executive committee. The executive committee consisting of the president, secretary, and treasurer of the organizing body, as well as the heads of all the main committees, should meet early and often to work out carefully each detail of the event, paying special attention to arrangements for general supervision control of, finances and selection of judges. A selection from the fair annual of the Worthwhile (Como, Walworth County) Farmers' Club shows plans and directions such as will be worked out by an enterprising executive committee:

THIRD ANNUAL FAIR

of the

WORTHWHILE FARMERS' CLUB

Rules and Regulations

The club will take every precaution for the safekeeping of all exhibits after arrival and arrangement, but will not be responsible for loss or damage.

Premiums are to be awarded only when articles are worthy of merit.

Entries will be divided into two classes: Junior, 18 years or under; senior, 19 years or over.

Be sure your exhibit is numbered and placed by superintendent before leaving.

All advertisers wishing ground space app'y to Charles Turner.

Dinner will be served at noon and in the evening.

Program of sports will be given in the afternoon.

Program will be given at 8:15 in the evening.

After program all exhibits donated to club will be sold at auction.

In naming judges, the committee should as far as possible depend upon farmers, housewives, and business men within their own county. When judges are invited from surrounding communities, the experience and confidence thus exchanged are valuable to all concerned.

Nominating committee. In order to get the fair started a nominating committee is usually appointed by the president of the organizing body. This committee should be representative of the different parts of the community. The duties of the nominating committee include the selection of the heads of fair committees and possibly the selection of other members of the various committees. However, this latter is sometimes left to the committee heads, with the understanding that each committee should include representatives from each section of the whole community. This list of superintendents from the Worthwhile Farmers' Annual may prove suggestive in the appointment of committee chairmen.

THIRD ANNUAL FAIR
of the
WORTHWHILE FARMERS' CLUB

Superintendents

School work	Mrs. Ed. Hicks
Vegetables and fruits	Chas. Tracy
Domestic science	Mrs. John Matteson
Grains and corn contests	Frank Drake
Livestock	Leo Dunlap
Pantry stores	Mrs. Carl Gray
Fancywork	Mrs. Chester Doan
Art and cut flowers	Mrs. M.-C. Flack
Farm machinery and advertising exhibits	Chas. Turner
Novelty booth	Mrs. Frank Abbott
Candy and refreshment booths	Miss Belle Ellsworth
Dinner committee	Mrs. John Brooks
Grounds	James Henderson
Marshal of day	Howard Reynolds

It is good advertising to have as many people as possible on the various fair committees. It adds to the interest of preparation. The fair is more talked about and the results are more keenly anticipated when every family in the community does its special share in the work of arranging for the community event.

The nominating committee must also keep in mind the psychology of suggestion when requesting individuals to accept the chairmanship of a committee. A person should not be urged to take part in the fair because it is such a small event that it will take little of his time or energy. Worthwhile people are not interested in trivial events that require little energy or thought. It takes a big, going movement to excite the enthusiasm of the dynamic people who will really get behind a fair and make it a success. So the nominating committee should always present the bigness of the proposition. The fair should be featured as an event so important, so big, that no person in the community can afford to stay out of it, or once in it, fail to do his super-best to come up to the fine average of the whole production.

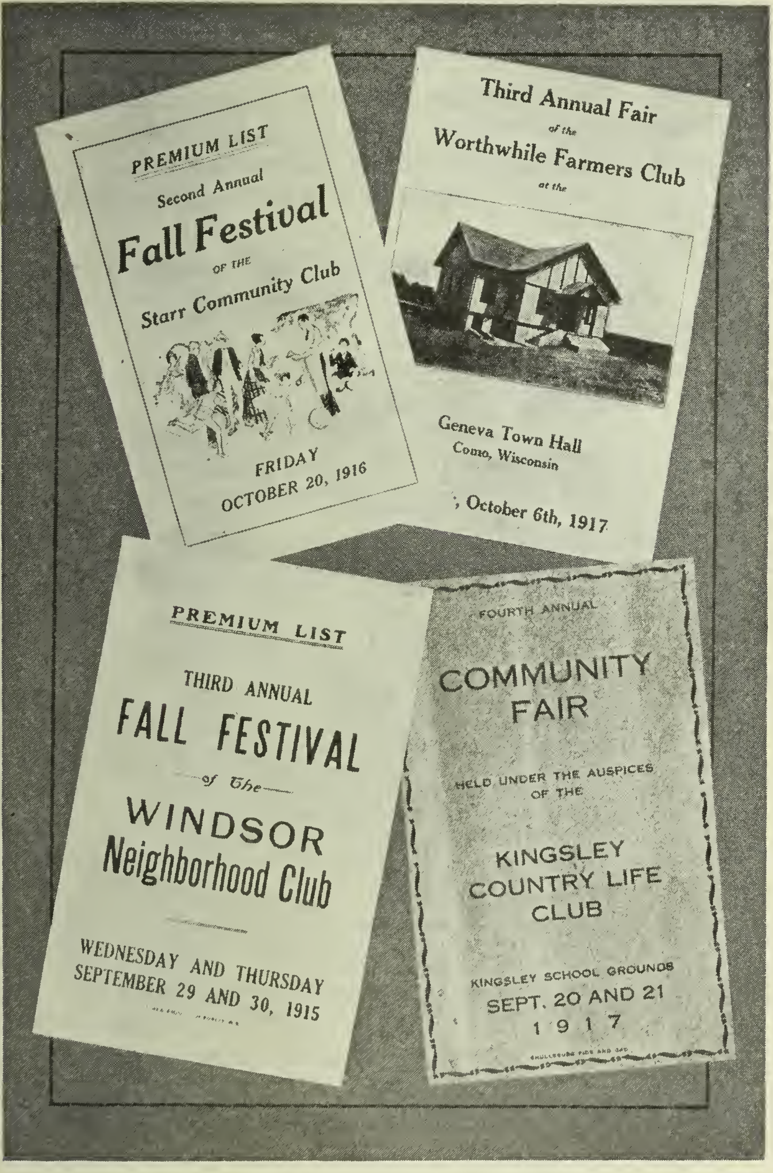
HOW TO ADVERTISE THE FAIR

Publicity committee. In order to build up the idea of bigness in the minds of the community, the nominating committee will have to have adequate support from a lively publicity committee. It is usually the duty of the publicity committee to get out in some form a fair annual and score card from four to six months before the fair.

The fair annual, if possible, should contain the names of the fair committees, the premium list, the score cards, rules and regulations. It may also contain slogans, songs, pictures, and short articles to boost the fair. It may or may not include paid advertisements.

Score cards which may be used in connection with the fair may be obtained from the county agent or the college of agriculture.

A fair calendar, made at the close of one fair and extending to the date of the next fair may be published by the fair publicity committee with good results. Such a calendar may contain suggestions, hints, and directions for the different seasons of the year concerning preparation of exhibits, steps in various contests, important meetings of various committees, and dates for beginning various entertainment preparations. It may also contain photographs of former fair exhibits and features, as well as slogans, yells, and colors.



PREMIUM LIST
Second Annual
Fall Festival
OF THE
Starr Community Club
FRIDAY
OCTOBER 20, 1916

Third Annual Fair
of the
Worthwhile Farmers Club
at the
Geneva Town Hall
Como, Wisconsin
October 6th, 1917

PREMIUM LIST
THIRD ANNUAL
FALL FESTIVAL
of The
WINDSOR
Neighborhood Club
WEDNESDAY AND THURSDAY
SEPTEMBER 29 AND 30, 1915

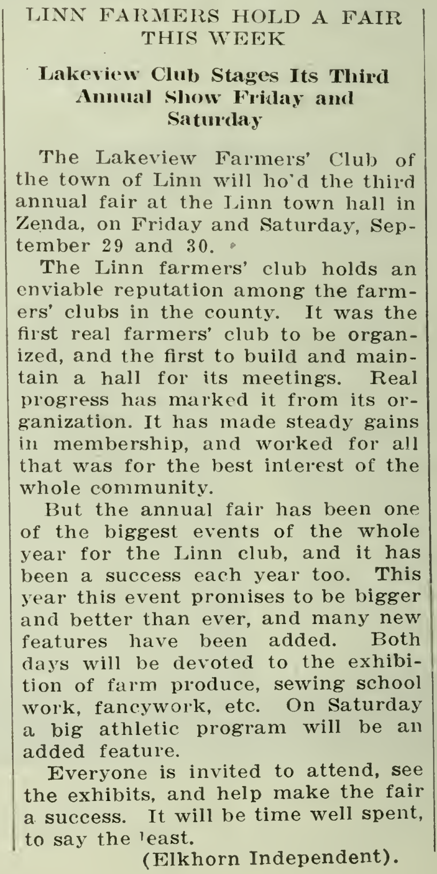
FOURTH ANNUAL
COMMUNITY
FAIR
HELD UNDER THE AUSPICES
OF THE
KINGSLEY
COUNTRY LIFE
CLUB
KINGSLEY SCHOOL GROUNDS
SEPT. 20 AND 21
1917

FIG. 3.—SAMPLES OF WISCONSIN COMMUNITY CLUB FAIR PROGRAMS

Each community will have its own ideas of booklets, catalogs, or premium lists. They need not be expensive.

"Write-ups." Much depends on the snappy entertaining "write-ups" concerning the fair which are put in the local papers during the weeks preceding the event by the publicity committee. These should include short items on such matters as features to be stressed at the coming fair; entries expected, important preparations, progress of contests; selection of judges and speakers; and the plans of near-by communities for similar fairs.

These two notices concerning the Linn (Zenda, Walworth County) Fair doubtless made each reader look forward to it with keen anticipation.



LINN FARMERS HOLD A FAIR THIS WEEK

Lakeview Club Stages Its Third Annual Show Friday and Saturday

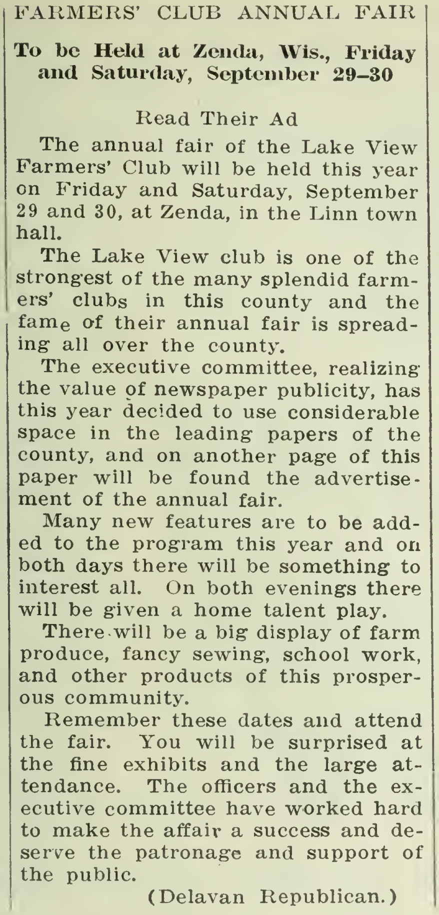
The Lakeview Farmers' Club of the town of Linn will hold the third annual fair at the Linn town hall in Zenda, on Friday and Saturday, September 29 and 30.

The Linn farmers' club holds an enviable reputation among the farmers' clubs in the county. It was the first real farmers' club to be organized, and the first to build and maintain a hall for its meetings. Real progress has marked it from its organization. It has made steady gains in membership, and worked for all that was for the best interest of the whole community.

But the annual fair has been one of the biggest events of the whole year for the Linn club, and it has been a success each year too. This year this event promises to be bigger and better than ever, and many new features have been added. Both days will be devoted to the exhibition of farm produce, sewing school work, fancywork, etc. On Saturday a big athletic program will be an added feature.

Everyone is invited to attend, see the exhibits, and help make the fair a success. It will be time well spent, to say the least.

(Elkhorn Independent).



FARMERS' CLUB ANNUAL FAIR

To be Held at Zenda, Wis., Friday and Saturday, September 29–30

Read Their Ad

The annual fair of the Lake View Farmers' Club will be held this year on Friday and Saturday, September 29 and 30, at Zenda, in the Linn town hall.

The Lake View club is one of the strongest of the many splendid farmers' clubs in this county and the fame of their annual fair is spreading all over the county.

The executive committee, realizing the value of newspaper publicity, has this year decided to use considerable space in the leading papers of the county, and on another page of this paper will be found the advertisement of the annual fair.

Many new features are to be added to the program this year and on both days there will be something to interest all. On both evenings there will be given a home talent play.

There will be a big display of farm produce, fancy sewing, school work, and other products of this prosperous community.

Remember these dates and attend the fair. You will be surprised at the fine exhibits and the large attendance. The officers and the executive committee have worked hard to make the affair a success and deserve the patronage and support of the public.

(Delavan Republican.)

Posters. The providing of posters will challenge to the utmost the ingenuity of a publicity committee. The field from which to select is wide. The forms which the posters may take are different as are communities themselves. However, it is well to keep in mind some main points such as clearness of type, large plain lettering, uncluttered spacing and striking make-up. A few photographs here given show the poster in various forms and sizes.

Naming the local fair. If the fair has not already been given a special name, the publicity committee may have the opportunity of selecting and popularizing an appropriate and suitable name.

A list of actual names of fairs may be found suggestive to those working for distinctive fair titles:

Fall Festival of the Star Community Club
Amenia Field Day
Spring Valley Harvest Home Festival
Livingston High School Agricultural Fair
October Festival and Institute
Oakdale Rural School Fair
Plowing Match and Fair
Boys' and Girls' Show
Neighborhood Fair
Grange Fair
The Apple Show
The Mid-Winter Fair
The County Products' Show
Rock Creek Township Fair
Farmers' Play Day
Creamery Picnic

Slogans are sometimes useful in "write-ups" and general publicity work. Here is a list of slogans that have been actually used and that may be found adaptable to the needs of the publicity committee:

"Every Farm a Factory."
"Get acquainted with your neighbor. You might like him."
"The Opportunity of the Town Lies in the Country."
"Get to Know Four Times as Many People as You Do Now."
"Be a Booster, not a Kicker."
"Do It for Your Home Town."
"Better Farming, Better Business, Better Living."
"A Greater Community, Agriculturally, Industrially, Socially, Morally."
"Let Good Neighbors Become Better Neighbors."
"Live Stock and Live People."
"We Must Beat Our Own Record."
"We Can Do It Ourselves."
"There Is More to Farming Than Just Knowing How to Farm."
"Add Sociability to Business and Get Better Business."

Photographs. The publicity committee should be constantly on the lookout for good photographs on subjects such as these:

Prize winners with prize products and prizes
Contestants working for results, as gardening, calf feeding at home
Exhibits at the fairs of former years
Other features of former fairs
Judges and speakers of coming fair
Some new fair building or fairground improvement
A new machine to be exhibited
A well-known dairy champion to be again exhibited
The school children getting ready for the fair, building a bird house
Scene from home talent play to be presented
Comparative surveys—watch for improvement!

Catchwords are sometimes of value in attracting the attention in "write-ups" and handmade posters. Pictures put with these phrases may serve many advertising purposes:

"Meet me at the Community Fair"
"I'll be at the Community Fair"
"Look here, fellows, are you getting ready?"
"I would live in a house by the side of the road"
"The Community Parade"
"We've found a way to keep them on the farm. Have you?"
"Why not join that garden contest now?"
"You'll be surprised!"
"Come and meet your neighbor—he will be there!"
"Should Auld Acquaintance be forgot?"
"All aboard the Fair Special!"

Special devices. Special devices in advertising the fair will be originated by every publicity committee for itself. In Wood County a post card like the following has proved a favorite method of working up interest and enthusiasm:

WOOD COUNTY BOYS' AND GIRLS' CLUB WORK
To Farm Bureau Members, Teachers, etc.

WHAT?	A Big County Exhibit
WHERE?	City Hall Place
WHEN?	Saturday, October 27, 1917
PRICE?	None, and No Side Shows
EXHIBITS?	Corn, Potatoes, Poultry, Pigs, Apples
EXHIBITORS?	Club Members of Wood County
TIME?	9 a. m. to 4 p. m.
FEATURES?	Judging Contest, Club EXHIBITS
FUN?	Auto Trip by Board of Commerce
PRIZES?	84 Offered, All Worth Winning
ENROLLMENT	Club Members for Next Year
SUPERVISED?	By County Agents and Farm Bureau
JUDGES?	Brownfield, Cook, and Tuckwiller
JOIN?	The Farm Bureau and Support Work
COMING?	SURE! Everybody will be HERE!

R. L. Buchanan,
County Agent

A "fair alphabet" telling of fair features may sometimes be chosen as a favorite method of advertising, as:

"ALFALFA DAY" on Wednesday
"BETTER BABIES" at the Fair
"CHOICE FRUIT"
"DAIRY TESTS"
(etc.)

Such leading statements as these will attract attention in newspaper items.

"Come to see the Scrub Cow's Trial."
"What the Community Fair will do."
"We will show you at the coming fair the two best cooks in the country."
"Wednesday is Crop Improvement Day, and Thursday is Good Roads Day."
"See the boys who have made 100 bushels of corn on an acre."

Booster campaign. A publicity committee may sometimes find it advisable to organize a regular "Booster Campaign" calling upon special talent for help in different lines. In this campaign booster and rally meetings may be held where songs and yells are learned. Special stunts are planned and talks are given by enthusiastic boosters. In Waupaca (Waupaca County) an especially original plan was worked out. One of the organizers describes it this way:

> As to advertising, a campaign was carried on by which each committee plugged for its exhibits and made prizes to people bringing best assortment of exhibits. Another good feature which we brought out was that whenever any of the individual agricultural students or members of committees visited at a rural school or social center meeting, they advertised the fair by a duet-dialogue on the things to be seen at the fair. This made a great hit and brought loads of people who otherwise, I think, would not have been there.

In Westboro (Taylor County), they made special use of handbills in advertising their fair, as may be seen in this account:

> We got out a great number of cards about one month before our fair was held and had these cards posted throughout the county telling all to come to Westboro on a certain date; also had the county agent write an article to the county papers explaining the fair. We used the slogan—"Westboro Does Things, Come and See." We have used this for a number of years on good roads work and it came in handily this time as the town has a reputation for good roads and citizens were willing to work to show we could do anything that we undertook.
>
> We put our handbills at the county fair, put up window bills, and in all places possible kept our bills moving for a month.

A regular farmhouse to farmhouse canvass may be made by booster campaign leaders telling of expected features and inviting people to enter products at the fair.

A button which says, "I am going to the Community Fair. Are you?" might sometimes prove a help. Stickers with pictures of some prominent fair features, together with the name and date of the fair may be distributed to people in the community to use on their cars and in their correspondence.

The boosters may wish to choose fair colors and in this case they should see to it that all "auto" banners advertising the fair, all posters, signposts, ribbons for the judges, chairmen, and mixers, tags, tickets and booth decorations carry out this color scheme whenever possible. Letters or post cards may be sent by the boosters to former residents telling them of the fair,

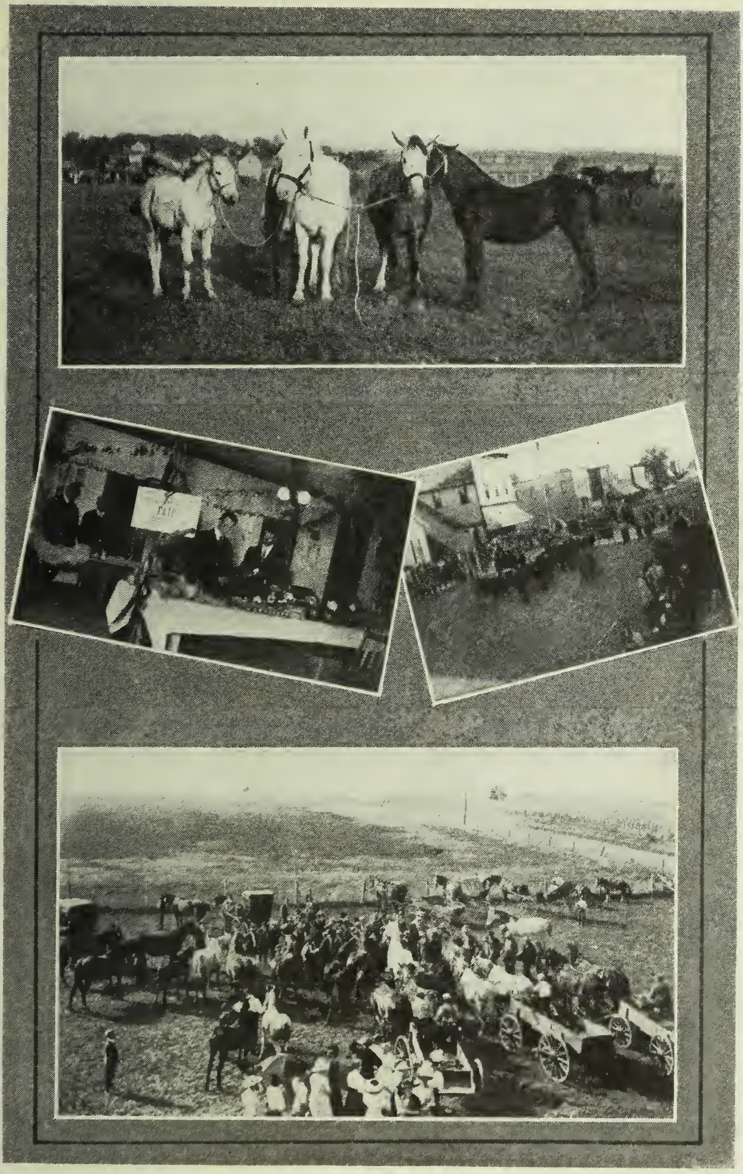


FIG. 4.—JUDGING CONTESTS PLAY AN IMPORTANT PART

Grains and livestock judging contests bring together the best the community can produce.

so that the home-coming atmosphere may thus add charm to the day's events.

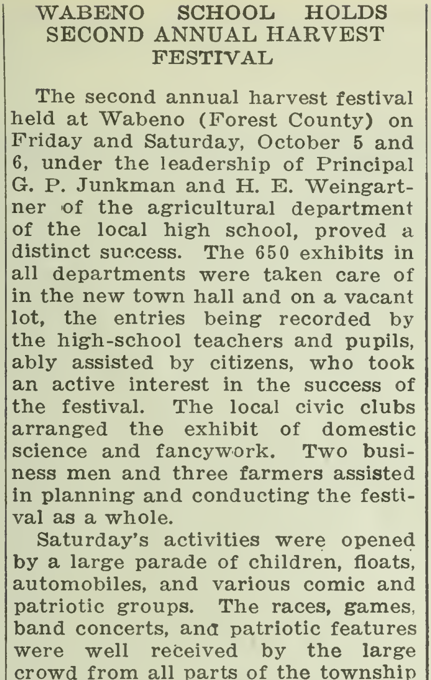
The follow-up campaign. The publicity committee also has charge of the follow-up campaign, which begins where the booster campaign leaves off. It should be the aim of the publicity committee to see that everyone who comes to the fair feels at home and has a good time.

To assure this spirit of cordiality, some of the most popular people in the community may be asked to act as booster-guides and mixers during the fair. These persons would strive to get people acquainted and still more thoroughly acquainted. They should do their best to see that the fair acts as an educator as well as a socializer, explaining and calling attention to features of interest and conducting special parties on trips through the grounds.

The follow-up campaign people should also do their best to insure a feeling of good will among contestants, doing all in their power to encourage the "good loser" spirit. They should take special care that strangers are entertained, and that the judges are hospitably received.

They should also encourage people to think of becoming exhibitors for the next year's fair and attempt to work up interest in special movements which the fair organizers are trying to promote for the next year, such as the "Know-Your-Kow Klub," good roads, and farm accounts.

The publicity committee should also see to it that good pictures are taken of all the attractive fair features. They may be used for cuts in "write-ups," displays in store windows, and the publicity campaign of the next year. Last of all, the publicity committee must not forget the duty towards all those who have worked together to make the fair a success. At best, after the fair is over, there are bound to be some grievances, disappointments, and worries among those who have exhibited, entertained, and worked for the welfare of the community. A printed word of appreciation and praise in the local paper will do much to soften any hard feelings, and will tend to leave all with a feeling of satisfaction and pleasure at having taken an active part in a successful enterprise. With good "write-ups" like the following, the people of the community are not likely to give up the fair the next year.



WABENO SCHOOL HOLDS SECOND ANNUAL HARVEST FESTIVAL

The second annual harvest festival held at Wabeno (Forest County) on Friday and Saturday, October 5 and 6, under the leadership of Principal G. P. Junkman and H. E. Weingartner of the agricultural department of the local high school, proved a distinct success. The 650 exhibits in all departments were taken care of in the new town hall and on a vacant lot, the entries being recorded by the high-school teachers and pupils, ably assisted by citizens, who took an active interest in the success of the festival. The local civic clubs arranged the exhibit of domestic science and fancywork. Two business men and three farmers assisted in planning and conducting the festival as a whole.

Saturday's activities were opened by a large parade of children, floats, automobiles, and various comic and patriotic groups. The races, games, band concerts, and patriotic features were well received by the large crowd from all parts of the township and county. The good quality and excellent appearance of the exhibits attracted the favorable attention of all in attendance.

In the evening, the public schools gave a patriotic program which formed an interesting and appropriate closing feature.

Such a cooperative effort on the part of the school and community cannot but be of much benefit to both. The success of this fair in the sparsely settled "Northland" indicates the possibilities of what may be done by schools in the older and more highly developed farming districts in Wisconsin. It also goes to show the value of a live agricultural department in the modern high-school.

HOW TO PRODUCE AND STAGE THE FAIR

Committee on arrangement. The committee on arrangement has the task of planning the fairgrounds. They must decide where the different booths shall be placed, where the entertainments shall be given and where the outdoor amusements shall be conducted. They must allot space to the different departments and see that material for booths and decorations is furnished.

At the Black Hawk fair, in which five rural schools participated, they arranged for the placing of exhibits as follows:

> On November 3, bright and early, the teachers met at the hall and arranged the material. Leading from the regular hall is another hall, somewhat smaller, but large enough. In this the Black Hawk school board put up steps along the length of the room, and a table through the center. On the steps were the vegetables, canned fruit and baked stuff, and on the table the manual training work. On the end walls we put up sheets, upon which we placed our school work and sewing.

If a color scheme for the fair is chosen, the committee on arrangement will work with the committee on publicity in making all parts of the fairground and exhibit rooms harmonize as far as possible.

Careful consideration must be given also to the general style of arrangement of exhibits, and instruction concerning this should be included in the fair annual and inserted in the early fair "write-ups." Special care should be taken to see that the exhibits are not cluttered in unattractive groups, but arranged in classes and uniformly placed.

The arrangement committee must also keep in mind constantly the educational values of the fair, and to this end provide each year for exhibits which particularly encourage the standardization of community products, concentrating on a few varieties of breeds and emphasizing uniformity of color, size, shape and marketing methods.

Posters should be attractively placed throughout the grounds calling attention to special features such as "Weigh the milk of each cow at milking time"; "Do you keep cow boarders?"

Slogans, legends, signposts, labeling placards, announcements, explanations, and banners all have their place in making the fair educational as well as social, and the use of these should not be forgotten by the arrangement committee.

The arrangement committee must also select the heads of subcommittees for arranging booths for stock, dairy products, grain, sewing, rural art, curios, boys' and girls' departments, potato clubs, pets, manual training work, and school exhibits.

A bulletin exhibit of recent valuable publications by the United States Department of Agriculture and by the State Experiment Station may also be arranged, with some responsible farmer in charge who will guarantee to send for bulletins for which farmers sign.

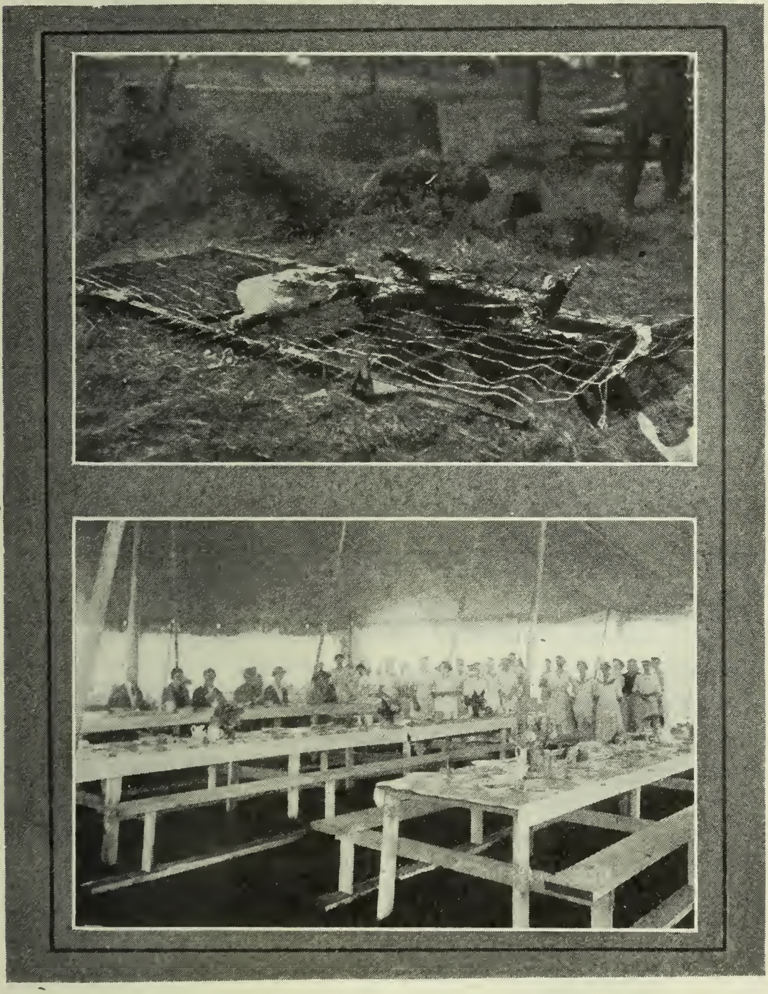


FIG. 5.—READY FOR THE HUNGRY CROWD

No mistake is made when preparations are made for feeding a hungry countryside. Roast beef and mutton are ready for serving.

Other exhibits, a little out of the ordinary, will occur to the committee as they carefully consider the resources and needs of the community. Some such exhibits as these may be worked out if they seem practical for the place and time:

"THE UNEXPECTED ALWAYS HAPPENS" EXHIBIT

- Reserve shelf for unexpected guests
- What to do in case of an accident
- How to mend the harness
- Substitutes in case some supply runs out
- First aid to the cow

DISPLAY OF HANDY DEVICES FOR BARN AND HOUSE

- A quick egg-separator
- A twin egg-poacher
- A power washer at work
- A self-feeder for hogs

"GOOD ADVERTISING FOR THE FARMERS' EXHIBITS"

- Approach to the farm
- Bulletin boards
- Ads in local papers
- Upkeep of road
- Farm name
- Farm stationery
- Standardized products
- Trade-mark
- "Look about your farm."
- System of farm accounting

PICTURE GALLERY EXHIBITS

- Local events
- Picnics
- Past fairs
- Club meetings
- Track meets
- Singing festivals
- Plowing matches
- Beauty spots of the community
- Sights of interest in other communities
- Things our community is proud of
- Copies of masterpieces

MODELS AND MINIATURES

- A farm kitchen in 1861
- An enlarged farmstead with better-farmhouse views
- A typical dairy farm in county
- A new successful type of silo
- Sanitary poultry house
- Babcock tester
- Modern beehive
- An ideal living-room
- Crop rotations
- A school playground as it might be
- Butter statue of famous cow
- A good trap nest, hen's eggs, model of hen, bag of feed
- Home market hamper packed for sending

DEMONSTRATIONS

Tractors
Potato-growing experiment plot
Milking machines
Buttermaking
Cheesemaking
Canning and cold-packing
Flower arrangement
Picture framing and hanging
Reforestation
Gasoline engines
Sanitary dairy
Selecting materials for clothes and table linen
Selection of seed corn
Seed-testing demonstration
Demonstration of use of right colors in and out of the house
Apple packing demonstrations
Dynamiting
Limestone crushing
Spraying
Stock and products judging
Table setting
Baking
Serving patriotic meals
Getting the horse ready for the fair
Corn stringing
Repairing

Some systematic provision for the entry and distribution of exhibits to the various booths must be made by the arrangement committee.

If this part of the fair is well worked out, endless confusion and misunderstanding will be avoided. There should, of course, be an entry register in which all exhibitors sign up and are given a number. All products should be left at some central point, where they are properly tagged, before being distributed by one in charge to the managers of the various booths.

Committees on special contests. There are several values attached to special contests. Contests are usually educational and include specific training. They also arouse community spirit. They encourage better farming. They are good advertisements for the coming fair and they add greatly to the interest of the fair itself.

The important thing in getting up contests is an early start. Six months before the fair the special contest committee should start with the help of the publicity committee in enlisting contestants, issuing terms of the contests, supervising any instruction necessary, such as a course of lectures or a series of articles in the local paper, for contestants. The committee must also inspect at frequent intervals, the work of the contestants in such contests as poultry raising, garden making, lawn improvement. In some cases the committee will also need to supervise the distribution of materials, such as seeds, or eggs. Finally, the most careful preparation must be made in order that the final presentation of the contest shall work off without a hitch at the fair.

The following contests have been successfully staged in various community fairs throughout the country:

FAIR CONTESTS

- Plowing matches
- Poultry raising
- Pig raising
- Sheep raising
- Harnessing
- Driving
- Judging contests (corn, horses, stock)
- Calf raising
- Potato raising
- Tomato raising
- Onion raising
- Corn raising
- Garden making
- Road dragging
- Pest killing
- Buttermaking
- Roadside betterment
- Five-acre contests
- One-acre contest
- School children's attendance
- Local rural photography
- Sanitation
- Health
- Kite-flying tournament
- Better babies
- Float contest
- Spelling
- Arithmetic
- Quotation
- Bird protection
- Clean-up contest
- Dairy contest
- Herd health contest
- Peach raising
- Good farm contest
- Egg-laying contest
- Canning contests
- Table setting
- Lawn improvement
- Cheese making
- Old settlers' reminiscence
- Beauty spot contest
- Rural art contest
- Rope tying
- Grain naming
- Baking
- Sewing
- Essays on Guernsey contest
- Good book contest
- Farmers' club contest
- Butterfat contest
- Athletic contests
- Fair attendance contest

Fun-making contests, such as pie eating, pillow fights, toe-wrestling, nail-driving, needle threading, whistling, clothespin contest, egg-rolling, slow auto-driving, chair-making race, corn-stringing contest.

No contest awakens keener interest or enthusiasm, nor appeals to a greater number of people than the plowing match, which is yearly growing in popularity among the community fairs of Wisconsin. The following description of the staging of the plowing match at Westboro (Taylor County) will give an idea of its splendid possibilities as a source of interest, education and inspiration.

WESTBORO PLOWING CONTEST

There never was a fairer day for a plowing contest than Friday, September 21, and there never was a better committee than the one which served at Westboro for the 1917 plowing contest.

The plowing contest at Westboro is a fine example of county agent work. The county agent inaugurated the plowing contest in Taylor county, but the people are making it a success. He is not teaching them how to plow, but each year they are doing better plowing. It correctly illustrates the county agent's work. Learn, "through him," not "from him," and give credit where credit it due to the committees that serve the people and the people that help.

It is estimated that 1,400 people visited Westboro last Friday and there was something doing all the time. During the forenoon the Medford band kept things bright with music while the committee was kept busy arranging and booking the exhibits as fast as they came in. The eight schools which were present in body also held school fair and picnic, as a part of the day's program.

During the noon hour coffee and buns were served and all through Fitze's woods were to be found groups and parties eating their picnic lunch.

After dinner Professor Galpin held the crowd for an hour telling of improving social conditions in the country through friendly gatherings and farmers' clubs.

Eight contestants were lined up for the plowing: R. H. Aitken, Jos. Imbach, B. Chas. Kuchenbecker, Gunder Nelson, John Posorski, Rich Rindt, Jos. Wacek and H. R. Wernestrand.

The plowing was under conditions that were rather favorable for good plowing. The field was an old sod, somewhat rough, dry, and more or less stony, but the plowing that was done was excellent.

The judges, Mr. Getchel and Mr. Ingalls, found the task of deciding rather difficult for there was much good plowing, but after totaling all scores and weighing all evidence, it was found that Rich Rindt, a man of tall, lean, Yankee, muscular type, ranked first. Rindt went with terrific speed, and used the same skill that a dentist uses in handling an instrument near a sensitive nerve.

R. H. Aitken ranked second, Jos. Wacek third, and Gunder Nelson fourth. The winner got the bull donated by the banks of the county, R. H. Aitken the sulky plow donated by Westboro, Jos. Wacek the Tamworth boar donated by the county agent, and Gunder Nelson the feed cutter, donated by the International Harvester Company.

All credit to Westboro and the committee that made the 1917 plowing contest the greatest event in the history of plowing contests in Taylor county.

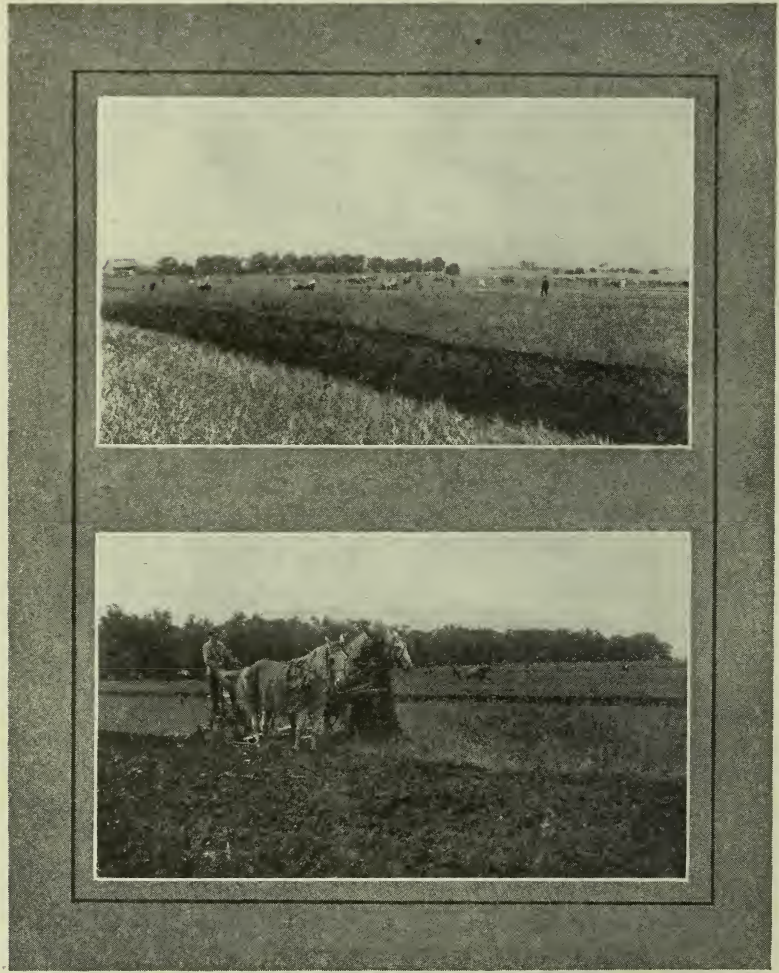


FIG. 6.—THE OLD-TIME PLOWING MATCH

The plowing match is more exciting than a football game. Who is the best man in your community?

Rules for plowing match. Each competitor with riding plow must use three horses and ride; gangs, four horses. Each plowman with single plow must plow one-half acre within three hours; gangs, three-fourths acre. No person will be entitled to more than one premium, and when entering must state in which class he wishes to compete. Plowing must be between five and six and one-half inches in depth, and should show a level bottom of each furrow. Plowman is not allowed to fix up his plowing after the plow has turned in. Plowing will commence at 9 o'clock a. m. sharp. All rules will be strictly enforced. Committee reserves the right to rectify mistakes as soon as discovered and settle all disputes that may arise, and their decision shall be final. All entries subject to approval of committee, and must be made not later than September 21, 1917. Agents for the different plow manufactories are expected to be present, and the following tests will be made: Quality of work, ease of handling and durability. Men and boys of adjoining towns are cordially invited to compete for all the different premiums. Judges of plowing are requested to report at field headquarters at 9:30 a. m. sharp and examine the work while in progress. No automobiles allowed in field while plowing is going on.

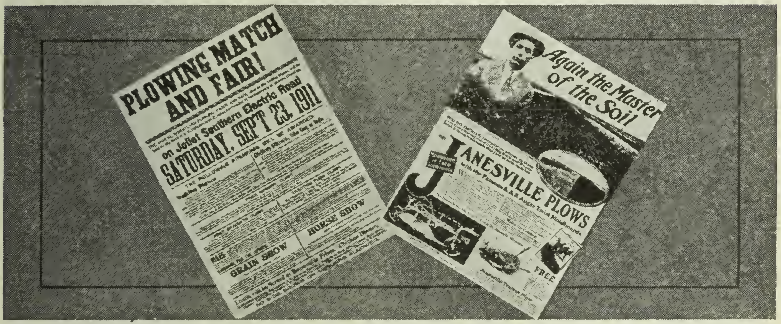


FIG. 7.—HONORED FAR AND WIDE

The winner of a plowing contest is known far outside his community. The contests are often widely advertised.

Guidance for judges. Good plowing consists of turning and setting the soil into nice, even, clean and straight furrows of roundish conformation. The following points will be considered: Evenness of furrows, 30 points; conformation of furrows, 30; straightness, 25; neatness, 15.

The committee on entertainment will have especially close relations with the boosters. This committee must secure the cooperation of good mixers before launching their program for the fair day or days.

Some communities find it a good policy to name the days of the fair in case the fair is of more than one day's duration, as

Livestock Day
Acre Improvement Day
All-Schools Day
Work and Wealth Day
Hospitality Day
Health Day
Settlers' Day
Farm Day
Market Day
Neighborhood Day

After the keynote of the fair has been determined, whether named or not, the committee on entertainment, should, after consulting with the executive committee, issue an outline of the fair program, including such features as:

1. Parades, before, during, or after fair—old settlers, prize winners, prize animals, children's pets' parade, baby carriage parade, boys' circus, pageant parade, work horse, automobile
2. Contests—select from list of fair contests
3. Special shows—as colt show, demonstrations
4. Music
5. Plays, pageants or concerts
6. Serving of refreshments—booth, banquet, or picnic
7. Excursion to some historical spot or some experiment ground or some place of special interest, as to new barn
8. Auction of exhibit products
9. Distribution of prizes
10. Meetings of different associations at fair
11. Honoring of public-spirited citizens
12. Erection of fair memorial
13. Lectures on various subjects, short and to-the-point

FG. 8.—FARMERS PLAY VOLLEY BALL

Grown folks never get too old to enjoy community games.

The following program carried out by an agricultural club at a local fair, has the necessary element of variety and completeness.

Grand parade of livestock
Judging horses, mules, beef cattle, sheep, hogs, ponies
Vaccination demonstration
Distribution of Spotted China pigs to pig club boys
Grand parade of prize winners (all horses, mules and cattle and all winners in every department will be expected to enter in this grand parade around the square)
Men's five-acre corn-growing contest
Athletic stunts, relay races, sack races, etc., will furnish amusement each day between judging periods

The purely social get-together spirit must not be forgotten. For sheer fun, relaxation and entertainment a few of these features may be selected:

Children's merry-go-round, ponies for children to ride, good movies—educational, music—community singing, concerts, glee club, band concert, professional musicians, victrola, dramatic forms—home talent play or opera, outdoor pageant or float, drama variety, boys' circus, costume dances on the green, games of all kinds for young and old, songs, yells, cheer leaders, registration—tags, picnic dinner with stunts, home-coming of old settlers, banquet at which nothing but home-growing products appear, banquet in new dairy barn, county chautauqua, parade of prize winners, getting acquainted contest, home talent play, pageant.

A leader of games with several helpers should be on hand to supervise and conduct such plays and contests as these:

For Children

Drop the Handkerchief
Blind Man's Buff—Still Pond
Pom-pom-pull-away
Miss Jennie Jones
Little Sally Waters
The Muffin Man
Princess Tiptoe
Go Round and Round the Village
Round the Mulberry Bush
Bean Bag Race
Old Roger
I See You
Old Grimes Is Dead
Soldier, Soldier, Will You Marry Me?
I'll Give You a Paper of Pins
Statues
Farmer in the Dell

Outdoor Games for Boys and Girls

40 Ways to Get There
Juggling Match
Needle's Eye
Did You Ever See a Lassie?
Three-Deep
Grab (The Miller)
How to Do, My Partner?
Lend a Hand

Outdoor Games for Boys

Three-legged race
Sack race
Bumps
Jumping contest
Relay race
Tug of war
Dodge ball
The Pursuer
Fox and Geese
Paper Chase
Chair-making race
Apple-ducking contest

Outdoor Games for Older Girls

Clothespin contest
Overhead relay
Potato race
Rainy-day race
Tug-of-war (Sticks of candy on string)
Paper Chase
Circle ball
Dodge ball
Prisoner
Fly Feather

Platform for Games for All—Pie-eating contest, pillow fight, quotation contest, community sneeze, whistling contest, letter game, charades, sentence match, rounds, nail driving, needle threading (for men).

The home talent play is always a drawing feature at the community fair, and will be taken over by the young people with great enthusiasm if the proposition is rightly presented to them. The following plays have been successfully given at community fairs:

The Rivals
She Stoops to Conquer
Scenes from Dickens
Uncle Rube
Between Two Lives (Burkett)
A Fatal Message (John Kendrick Bangs)
A Russian Honeymoon
Cherry Tree Farm (An English comedy)
Leonarda (Bjornson)
Sam Average
The Traveling Man
For the Cause
A New Liberator
Bridging the Chasm
A Farmhouse Scene in Iceland Thirty Years Ago
The Prairie Wolf
Back to the Farm
A Bee in a Drone's Hive

When the fair lasts but one day, if a local play is planned, it is generally given in the evening as at the Milltown (Polk County) Fair.

> There was an entertainment in the evening held in the assembly room of the school. It consisted of one part contributed by the girls' glee club, and so forth, and another part, a minstrel show by the boys. Admission charges of 15 cents and 25 cents were made and the assembly room was crowded to capacity. Net proceeds from the entertainment after paying for stamped ribbons, exhibit coops, and so forth, for the fair were about $40. Part of the money was spent for a large flag to drape above the stage in the assembly room and some more for sliding curtains for the same stage. The remainder is turned over to the picture and piano fund for the high-school.

A popular variation of the home talent play is the homemade pageant. The pageant may be in the form of a float parade as at Windsor (Dane County) and Spring Green (Sauk County). In some cases, a more elaborate preparation is possible as in the case of the Holcombe (Chippewa County) Pageant of 1917, described in the local papers as follows:

> **The Pageant on Thursday**
>
> The historic pageant featuring the fair illustrated vividly the more distinct stages in the development of the Holcombe country. It was proclaimed by visitors to be of tremendous value, educationally, and as a historic sight can never be duplicated. The characters making up the "march of civilization" were real. The old trapper, cruiser, lumberjack, were the same men who years ago fought the elements in the north woods and will soon pass across the great divide for well-earned rest.
>
> **When Indian Was Supreme**
>
> In the pageant were represented the life of the community in the days when the Indian was supreme, when trappers and traders entered and the timber cruiser prepared the way for the first industry; when the pioneer loggers began operations with primitive methods; when the farmers came in; thereafter the development

of the agricultural up to and including the present time.

Intensely Interesting

In the line were the Indians in native costume, most of them from the Flambeau country; the trapper wearing a fur cap and carrying his traps; a grizzled timber cruiser of the "sixties"; an ox team and jumper with a load, carrying that estimable pioneer, Mrs. A. J. Edminster, and supplies such as were used in the first logging camps; woodsmen of the early days; pioneer river men; farmers in old-fashioned lumber wagons containing simple and primitive household goods, and succeeding farmers with more modern paraphernalia representing the development of the agricultural equipment up to the present. The line ended with a drove of fine high-bred stock brought in from near-by farms.

Explanation of each section of the pageant was afforded by banners, each bearing a couplet from a poem written for its use by A. J. Edminster and it is well worth preserving. Below we publish it in full.

The Real Pioneer—
All honor to the red man whose lands he did divide among his paleface brothers that they might here reside.

The Jesuit Father—
The first white man, though not the least, and history does honor to the Jesuit priest.

The Trapper—
The trapper scents the odor of the furs so slick and fine.

The Cruiser—
And the cruiser hears the whisper of the winds among the pine.

The Lumber-Jack—
Where the cruiser ever ventures, there is always on his track, the man that handles saw logs, the rugged lumber-jack..

The First Tote Team—
The lumber-jacks had appetites of an enormous size, so they used this conveyance to haul in their supplies.

The River Pig—
The lumber-jack has graduates, with calk boots he feels big, for he knows that all the boys can't be a river pig.

The First Horse Team—
The small horse is entering, it seems to be his day.

The Larger Team—
But destiny sent a larger horse our way.

More Development—
The lumber-jacks go home and advise all their relation, that the land up on the Chippewa is the best in all creation.

The First Farmer—
Their methods may be simple, but to all this thought is clear, there's none that starts the progress like the sturdy pioneer.

And His Neighbor—
This land has gone back for taxes, on the county it's a drain, but we'll show those supervisors how to farm it just the same.

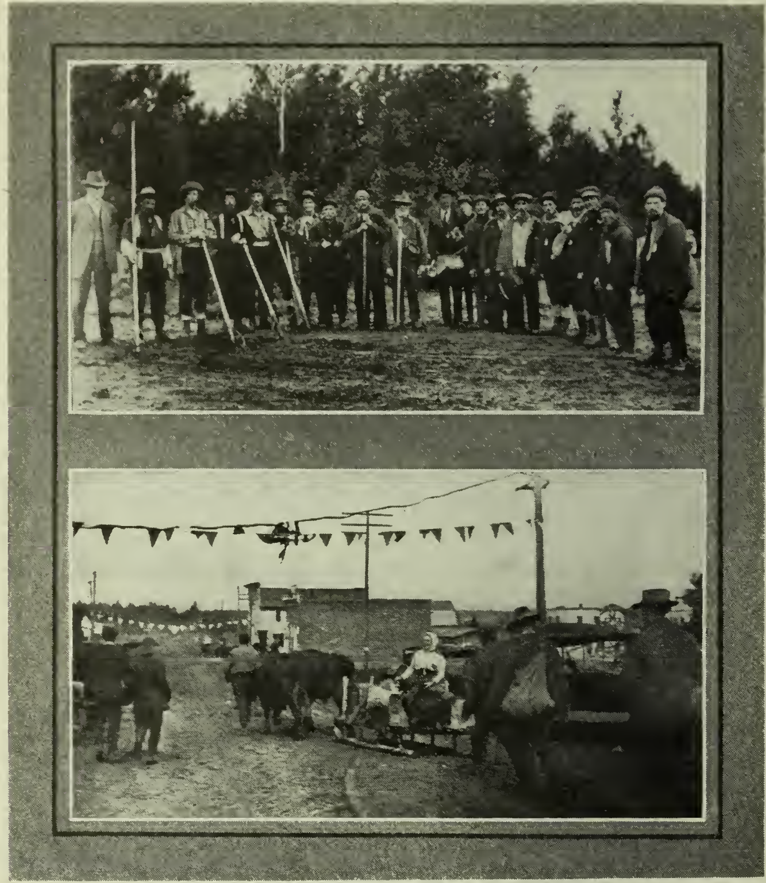


FIG. 9.—THE COMMUNITY HISTORY

A living picture of the past and present is staged. The pageant is effective and aids in building community pride and spirit.

The First Cow—
I traded off my watch chain and a musket for this cow. Say, won't my wife be tickled? We'll do some farming now.

The First Preacher—
The settler is sometimes careless in doing as he ought, so the preacher enters in to instill religious thought.

And Then What—

A few meetings held, a few converts made, and then we organize the First Ladies' Aid.

The First Church—

The ladies, always planning, go forward with a lurch, and the product of their labor is the pioneer church.

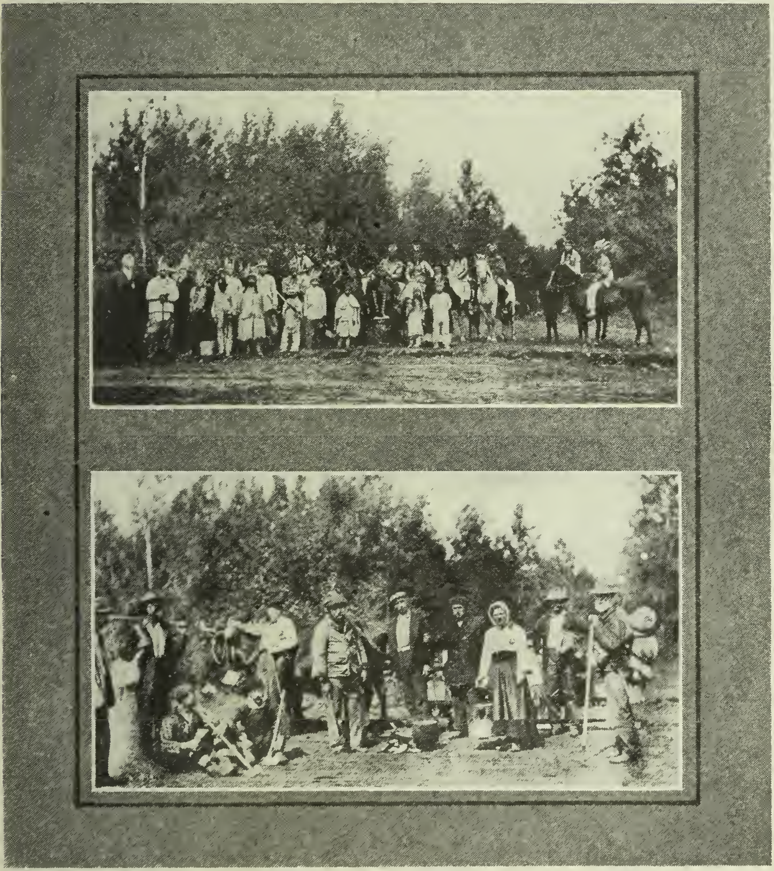


FIG. 10.—THE PIONEER STORY

From the time of the first settler to the present makes an effective community pageant.

The First Doctor—

The doctor now is needed who must travel through the woods, and attend to all the ailments in the various neighborhoods.

Fraternal—

We are fraternally united, in all that's for success, and for peace and harmony we rank among the best.

Again We Advance—

You will find among us "progress," too, if you follow up our path, we have thrown away the cradle, and the sickle, scythe and snath.

Better Stock—
At this stage, this beast to you may look absurd.

Look Again—
But here we have the evidence, he's the father of this herd.

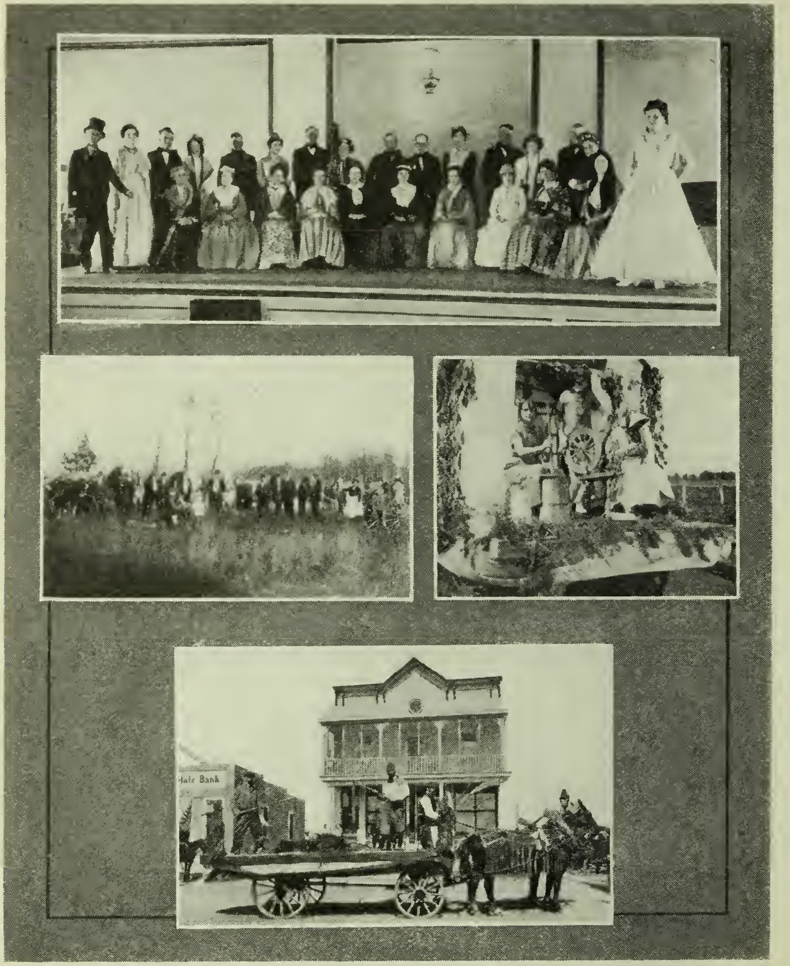


FIG. 11.—DRESSED UP FOR THE FAIR

Folks are never too young nor too old to play a part and make believe. Pageant or float presents bygone days.

Well, Well, the Community Kicker—
Here comes the village kicker, with his long-drawn-out face, smashed by the wheel of progress, he will soon have run his race.

He Says—
"I've kicked and growled, and I'm going to quit the whole of you, and go and cast my lot in ranks of I. W. W.; I have tried to stop de-

velopment in all these years, but I see my funeral sermon will bring joy instead of tears."

Holcombe Boys' and Girls' Club—
Now the boys and girls have organized in an effort to help their dads; the result is more and better farming; thanks, to the lassies and the lads.

The Holcombe Farmers' Club—
The Farmers' Club comes next, and all say in one accord; that this garden of the forest has helped them to a "Ford."

The entertainment committee will also be responsible for providing music, either band or victrola, orchestra or glee club. They must not forget the youngsters, and should provide, if possible, a merry-go-round and a balloon stand. Cheer leaders and song leaders should do their part in keeping the crowd happy and interested. A rest room of some kind should be provided. At Spring Valley (Pierce County) a notice was put in the fair annual.

> REST ROOM FOR LADIES
>
> The New Hall will be open all day, with a Rest Room for ladies, also a check room. Small children may be left here in charge of the Matrons.
>
> MEALS
>
> Good meals may be had in the dining room of the New Hall, served by the Women's Auxiliary.

The committee on grounds. Although the duties of the committee on grounds are relatively few, it is quite essential that they carry through their part of the fair enterprise with thoroughness.

This committee must see that the grounds as a whole are in fine condition on the opening morning of the fair and that they are kept so all during the fair. Receptacles for waste material should be provided. Boy scouts should be enlisted for police and monitor work, and everything possible should be done to keep the fair premises in spick and span order, for a slipshod fairground is a poor advertisement for an up-to-date community.

The committee on grounds also has in charge the granting of concessions and must exercise caution regarding cheap or harmful innovations along this line. In case any money is left in the treasury, the fairground committee may possibly be allowed to add some improvement to the fair premises each year, perhaps putting up some memorial, such as a fountain in the park or a flag pole.

Committee on prizes and awards. The committee on prizes and awards has need of keenest judgment and discrimination from the time their work begins until the last prize is awarded. In the first place, they must consult with the executive committee concerning the amount which is to be expended in prizes Having determined this, they must then apportion the prizes among the different contests, and exhibit departments. The next step after this is deciding upon the relative value of prizes in each department.

Next must be determined the types of prizes to be awarded clubs, schools, districts, families and individuals; types of prizes for farmers, farmers' wives, farm boys, and farm girls must also be selected. After this has been done, the committee will then determine the kind of prizes to be given. Prizes may be classified roughly as follows:

(a) Money prizes—new currency, gold pieces
(b) Honor badges—ribbons, buttons, pins, banners, pennants, silver cups, official letter "F" (Fair)
(c) Prizes of educational value, as farm papers, kodaks, purebred hog
(d) Prizes which unite interests of farmer and merchant, such as an amount in trade, fireless cooker given by merchant

Prizes may be purchased from fund taken from the fair appropriation or they may be solicited from farmers, housekeepers, merchants, editors, manufacturers, stock breeders' associations, seed and nursery houses and other sources.

Placards announcing the prize awards should be posted on the fair grounds at intervals during the day. This keeps up an interest in exhibits, and gives the judges opportunities for explaining and instructing concerning points in the score cards.

A parade of all the prize winners and prize stock should, if possible, be staged at some time during the fair, but the actual distribution of prizes should be deferred until some time when an uninterrupted, dignified program can be arranged and carried out. It is better to wait until the evening following the fair or later, if possible, for then people will not be so weary and can enjoy the program without feeling hurried. Provision should be made for a regular program. Prize winners should appear upon the platform to receive their awards and the applause of the community. All this may seem a great deal of trouble, but in the end it pays, just as it pays to insert into the paper a word of appreciation after the fair is all over.

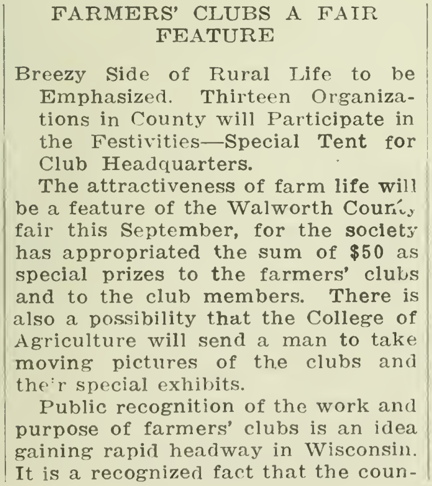
HOW TO UTILIZE THE FAIR

The fair brings results. Many good results are sure to follow such faithful persistence in the policy of courtesy and consideration on the part of the fair organizers. New interest in community enterprises is bound to spring up, a better neighborhood spirit is likely to prevail, and each household in the community will go back to its tasks with renewed hope.

The following are some of the results for which fair organizers may work, either directly or indirectly, all the way through the preparation, staging and exhibiting of the fair.

Good roads committee
Boys' and girls' club
Farmers' institute
Community club house
Farmer-banker association
Community laundry
Improvements in the home (running water—gasoline)
Engine washing-machine
Better school lunches
Parent-teacher association
Cooperative marketing
Lyceum course
Writing of the community history
Founding of community library
Reading of good literature on agriculture
Better taste in house furnishing and farm surroundings
Livestock improvement association
Cow testing association
Debating society
"Alfalfa Day" or "Seed Corn Week"
Installation of good movies in town

Farmers' clubs at the county fair. Among the most interesting of the outgrowths of the community fairs is the Walworth County plan of having Farmers' Club Day when the farmers' clubs compete, visit, and play together at the county fair.

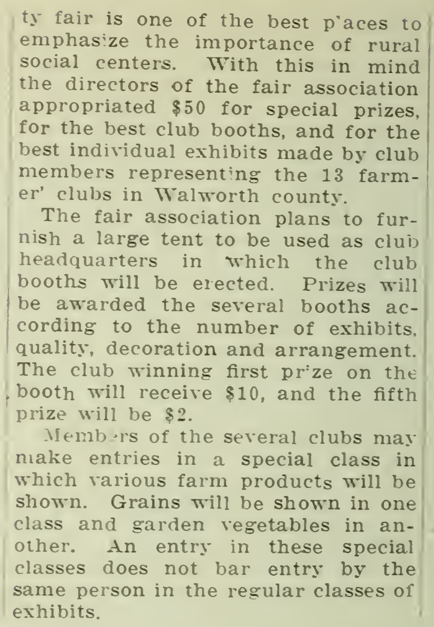


FARMERS' CLUBS A FAIR FEATURE

Breezy Side of Rural Life to be Emphasized. Thirteen Organizations in County will Participate in the Festivities—Special Tent for Club Headquarters.

The attractiveness of farm life will be a feature of the Walworth County fair this September, for the society has appropriated the sum of $50 as special prizes to the farmers' clubs and to the club members. There is also a possibility that the College of Agriculture will send a man to take moving pictures of the clubs and their special exhibits.

Public recognition of the work and purpose of farmers' clubs is an idea gaining rapid headway in Wisconsin. It is a recognized fact that the coun-


ty fair is one of the best places to emphasize the importance of rural social centers. With this in mind the directors of the fair association appropriated $50 for special prizes, for the best club booths, and for the best individual exhibits made by club members representing the 13 farmer' clubs in Walworth county.

The fair association plans to furnish a large tent to be used as club headquarters in which the club booths will be erected. Prizes will be awarded the several booths according to the number of exhibits, quality, decoration and arrangement. The club winning first prize on the booth will receive $10, and the fifth prize will be $2.

Members of the several clubs may make entries in a special class in which various farm products will be shown. Grains will be shown in one class and garden vegetables in another. An entry in these special classes does not bar entry by the same person in the regular classes of exhibits.

The following directions are for the help of farmers' clubs which wish to amass the best from their community fair for reproduction at the county or state fair.

Suggestions for a farmers' club exhibit. A farmers' club exhibit may be planned with several objects in mind. Some parts of it may be for amusement; other parts for more serious entertainment; other parts for education; and other parts to bring out the best things of the different communities in order that they may realize what has been accomplished in their own community, and perhaps feel a stimulus toward a friendly neighborhood rivalry in matters of community improvement.

General suggestions. As to the means of carrying out the aims already mentioned, some general suggestions may be given:

1. **Each club might enter a float in a parade.** The floats might be constructed with the idea of beauty, or with the idea of producing something unique and laughable, or to bring out some neighborhood feature which is distinctive.

2. **An entertainment program** might be arranged which would consist of numbers representative of the different clubs. If ten or twelve clubs were taking part, each number should be limited to about eight minutes. The numbers might consist

of songs, a local talent play, dialogues, recitations, exhibitions of some sort, or any form of entertainment or stunt. Special consideration might be given to anything which emphasized or demonstrated the value of the farmers' club, its work, or modern methods of farming.

3. The exhibit of farm produce. This would necessarily be limited, and because of this fact, it might even be desirable to eliminate it entirely. If practicable, the committee might look carefully over the community and pick out good practical farmers who are especially successful in one or more lines, such as dairying, or the production of corn or oats. These might be induced to make an exhibit which would call attention to the methods by which they attained their results. A still better method would be for each club to hold a preliminary exhibit but at the same time seek for the same end.

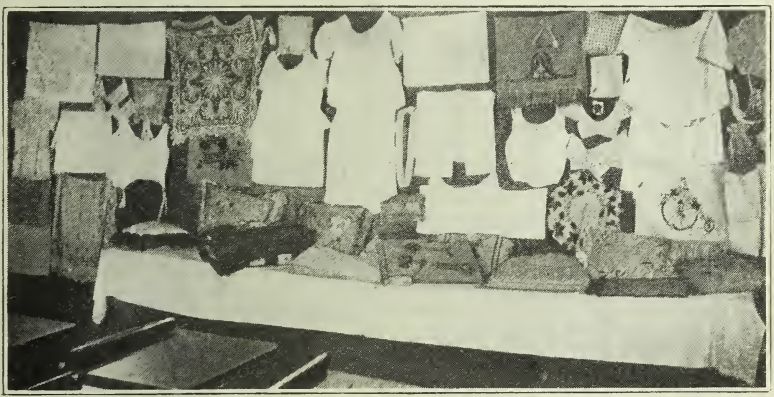


FIG. 13.—LET THE WOMEN FOLKS HAVE THEIR PART

Bring to the fair the pretty things made at home or in the classes at school.

4. As the school is a community institution, it should also have a place in the exhibit. This exhibit might consist of a photograph of the schoolhouse and grounds, another one of the interior of the building, and also an exhibit of the school work.

5. A picture gallery containing photographs of local scenes and people, made by amateurs. This might include pictures which would call attention to beautiful or interesting scenes, attractive farmhouses, well-planned buildings, livestock, crops, good roads, and so forth. It might also include pictures of community events and any other things which would be of interest to local people. Later these might be used in making a club album to which additions might be made from time to time.

6. In order that the people may come to appreciate their degree of prosperity and progress and their standing with relation to other communities, and that free rivalry may be stimulated between different communities all looking toward improvements on the farms, in the homes, and in the community institutions, some exhibit might well be made which would call people's attention to these things.

Three general methods might be used.

First, pictures—for instance, those already described as showing the prosperity and progress of the community—might be shown. **Second**, models of farm layouts might have a place in such an exhibit. **Third**, small signs or placards showing certain facts about the community.

SPECIAL SUGGESTIONS AND DIRECTIONS

Models might be made by groups of the boys or young men without excessive amount of work, provided some direction and supervision could be given by an older person. If there is some farm in any community which is noteworthy for either layouts or rotations a miniature model constructed in a shallow box filled with earth, and with different crops growing in it, would be very attractive.

Placards should be made from white cardboard, and the lettering should be large enough to be read about 12 or 15 feet away. These placards might be placed on the walls of the booth allotted to the club. The facts used in making these cards could be collected by different committees appointed from the club members. Some typical cards are:

Club Membership

Total population of community............
Total membership of the club............
Percentage of community in the club............

Modern Lighting

Number of homes lighted by gas or electricity............
Number owned by club members............
Percentage of all homes having modern lighting............

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Bulletin 308 December 1919

ALFALFA IN WISCONSIN

R. A. MOORE
L. F. GRABER

AGRICULTURAL EXPERIMENT STATION
OF THE UNIVERSITY OF WISCONSIN
MADISON

DIGEST

Alfalfa is a coming hay crop in Wisconsin. Where grown successfully it outyields all other hay crops and is a most valuable feed. It resists drought, eradicates weeds, and improves the soil. Pages 3 to 8.

Clover is sometimes better than alfalfa. There are places where it is hard to get a stand of alfalfa and where clover grows like a weed. Page 8.

Alfalfa does best on a soil with good under-drainage and a gravelly limestone subsoil. Lime is the greatest need of alfalfa and the lack of it is the chief reason for failures from poor soil conditions. Have the soil tested before seeding. Inoculation also pays. Pages 9 to 16.

The seed bed should be firm, fine, and well-prepared. Spring seeding is best with an early-ripening nurse crop. The young alfalfa needs help to fight weeds the first six months. The rate of seeding varies from 15 to 20 pounds to the acre. Pages 16 to 22.

Timothy and alfalfa make a good combination. The timothy takes the place of any alfalfa plants that are winterkilled. Page 23.

Alfalfa, like clover, winterkills. Avoid late cutting or late pasturing, avoid poorly drained soils, and sow varieties which are hardy. Some varieties of alfalfa resist winterkilling to a marked degree. Grimm, Baltic, and Cossack are most resistant, but it is difficult to get genuine seed of these varieties. Pages 23 to 31.

Three cuttings of alfalfa are obtained in favorable seasons. Curing the hay in windrows and not in swaths is highly important. The crop is most easily handled with side delivery rakes and drum hay loaders. Pages 31 to 36.

Alfalfa in Wisconsin

Alfalfa growing is popular in Wisconsin because of the numerous advantages of the crop. Where it can be grown successfully it excels all other hay crops in yields to the acre, feeding value, drought resistance, soil enrichment, and weed eradication.

Thirty years ago alfalfa was practically a stranger in Wisconsin but its introduction and dissemination have gone on at a rapid pace until it is estimated that 60,000 acres of this great forage are now grown in the state.

OUTYIELDS OTHER HAY CROPS

A trial conducted on the Wisconsin Experiment Station farm in which yields of hay and protein per acre from alfalfa, clover and timothy were compared, showed that alfalfa gave practically double the yields of clover hay and three times that of timothy. Alfalfa produced in a single season three times as much protein per acre as clover and nine times as much as timothy.

HAS A HIGH FEEDING VALUE

Alfalfa is noted for its high feeding value. Farm animals are fond of it and the high protein content (approximately 15 per cent) makes it exceedingly valuable for milk and meat production. Feeding experiments have not shown it to be decidedly superior to red clover but average farm experience gives it first rank as a nutritious and palatable hay. Well-cured alfalfa is practically equal to bran in feeding value. It takes the place of costly feed stuffs and reduces the feed bill. It is relished by all farm animals.

MORE DROUGHT-RESISTANT THAN CLOVER

Because of its large root growth alfalfa exerts a beneficial effect on the soil in which it grows. Through its power to feed upon the necessary soil elements for growth and to secure moisture at great depths below the surface, alfalfa is able to stand severe drought. When other hay crops are brown because of drought, alfalfa often continues its green growth, drawing moisture and plant food from depths to which other forage plants are unable to penetrate. This is noticeable not only in old stands where the roots are deeply entrenched, but with new seedings, of which the first year's growth is much more drought-resistant than that of clover.

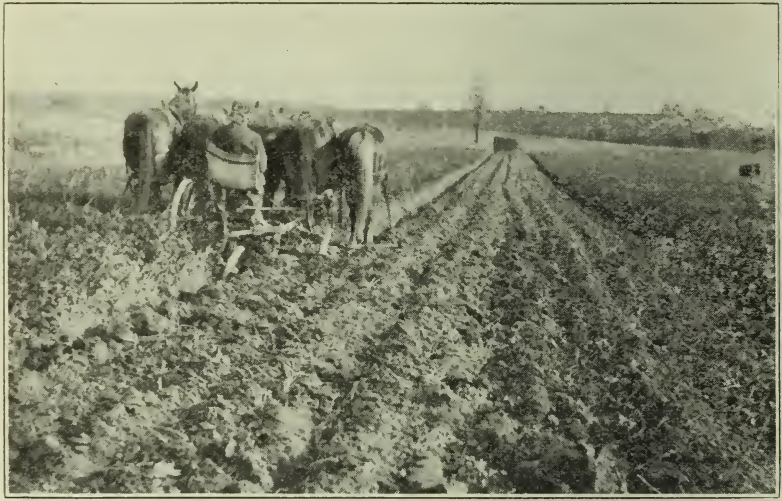

FIG. 1.—PLOWING UNDER THE THIRD CROP OF ALFALFA

Corn will show how alfalfa makes the land rich.

Evidence of this fact is well shown by the reports of several members of the Alfalfa Order, Wisconsin's state alfalfa growers association, received during the summers of 1918 and 1919. Alfalfa and clover were sown adjacently and in the same fields, under uniform soil conditions and in the same manner. The clover succumbed to the summer's drought while the alfalfa came through in excellent shape following fall rains.

Because the nature of the plant is to send into the soil vast numbers of roots, the soil, even though previously compact, becomes porous and friable when alfalfa is grown. Later, when the land is plowed and fitted for other crops, the physical condition of the soil will be found very much benefited. The mass of root growth, which decays when the plant is killed, adds materially to the humus and increases the fertility and productivity of the soil.

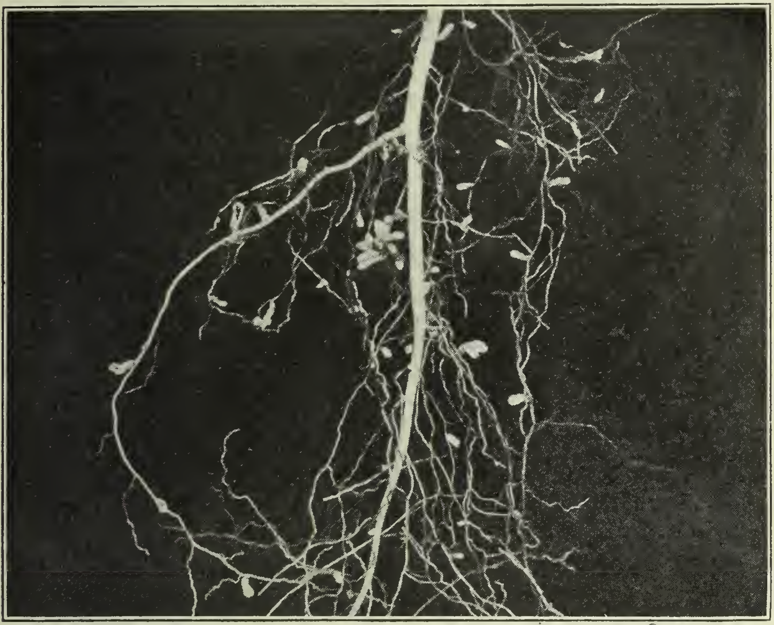

FIG. 2.—FERTILIZER FACTORIES ON ROOTS OF ALFALFA

The little white swellings or nodules on alfalfa roots are sure indications of proper inoculation. They are the homes of millions of alfalfa bacteria which gather nitrogen from the soil air and convert it into an actual growth-producing fertilizer for the alfalfa plants.

FERTILIZER FACTORIES ON ALFALFA ROOTS

Alfalfa, like clover, beans, peas, vetches, or other legumes, is one of those great renovating plants which add fertility to the soil by means of the free nitrogen they are able to get from the air. If an alfalfa plant from a successful alfalfa field is taken up by the roots, it will be noticed that the fibrous roots are covered with small bunches. These swellings, or nodules, are the homes of millions of minute bacteria which absorb the nitrogen from the air and convert it into food for the plant. This food is essential for successful plant growth. A good stand and favorable growth of inoculated alfalfa may add more than a hundred pounds of nitrogen to an acre of soil each year, provided all manure from the alfalfa hay is returned to the soil which grew it. Where bacteria are not present in the soil, this nitrogen-fixing process does not occur.

ALFALFA IS A WEED ENEMY

In the early stages of growth of alfalfa, weeds are a menace. After the crop becomes well established it, in turn, becomes a menace to nearly all bad weeds, except quack grass.

The Canada thistle has long been a dreaded enemy of the farmer. The persistent growth of this noxious weed and the necessary expense and labor involved in keeping it under control have levied a heavy tax on some farms where it has become established. Within the last few years many farmers have reported complete success in eradicating large areas of Canada thistles by growing alfalfa. The rapid and dense growth of alfalfa after each of the two or more cuttings it annually receives, greatly weakens the Canada thistle plants. They gradually die and at last the entire field of alfalfa is free. The success with which this may be accomplished is entirely dependent on securing a good thick stand of the alfalfa. Often good results have been secured by following one of the standard methods of seeding of alfalfa, without any particular efforts in the way of previous cultivation other than that necessary for the correct preparation of the seed bed.

More certain results can be obtained by plowing deep in the late summer or early fall, soon after a crop has been removed. The possibility of soil washing will have to be considered before fall plowing is undertaken. The soil should be harrowed often enough through the fall, preferably with a spring-tooth harrow, to keep the Canada thistles well subdued. Harrowing will drag many of the roots to the surface, where they will be killed by exposure to the sun. As early in the spring as conditions permit, the soil should be plowed again, and until about the last week in June it should be harrowed or disked as often as necessary to free the land of all visible weed growth. If the Canada thistles cannot be fully controlled by harrowing, another plowing is advisable a week or ten days before seeding. Good judgment must be used, as this matter depends entirely on conditions.

By the last of June the Canada thistles should be well subdued by the cultivation the soil has received. Then, after the land is carefully inoculated, manured and otherwise put in the best condition, the alfalfa seed may be sown alone without a nurse crop at the rate of 20 to 25 pounds an acre. When the alfalfa has grown eight or nine inches the Canada thistles and other weeds may also be abundant, and clipping the field not later than September 1 is advisable. The next year the thistles will come again, but the alfalfa soon develops an overmastering growth, and with the frequent cuttings the crop receives, it seldom takes more than three years to eradicate the thistles. All the while profitable crops of valuable alfalfa hay are being secured and the soil is being freed from the growth of one of the most serious noxious weeds. This is a benefit which is not received from any other hay crop. It is true that a timothy sod or a good crop of clover may, in a measure, subdue bad weeds, but neither crop can be compared with alfalfa for

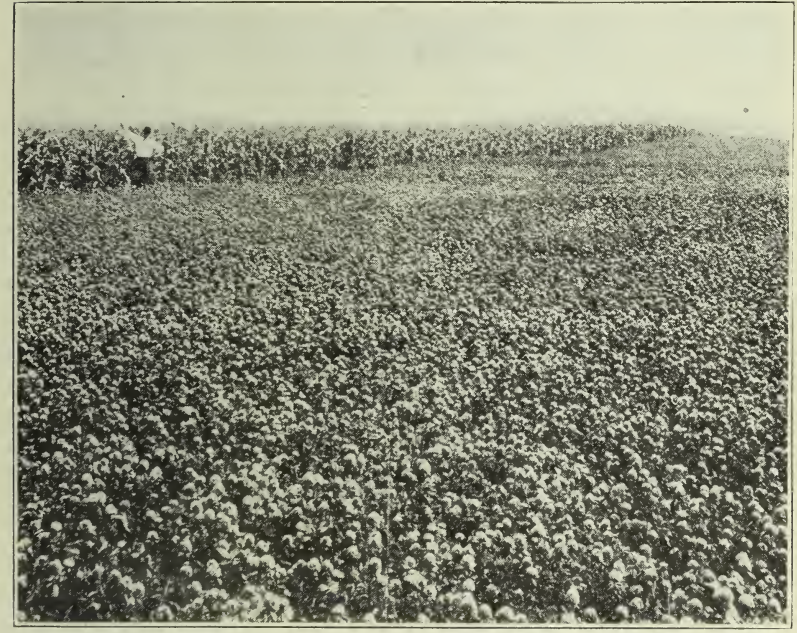

FIG. 3.—WHERE CLOVER GROWS LIKE A WEED

If clover grows easily and it is difficult and costly to establish alfalfa, grow clover.

successful weed eradication, particularly of Canada thistles. Clover does not last long enough and timothy does not grow fast enough.

WHERE CLOVER MAY BE BETTER THAN ALFALFA

It is not intended to urge the growing of alfalfa on every farm for there are large areas where clover is a more profitable crop. The greater portion of northern Wisconsin, where much of the land is newly cleared, grows clover like a weed. That alfalfa can be grown there with the use of lime and inoculation has often been demonstrated, but with clover so abundant and so luxuriant in both forage and seed production, and so certain and easily established without the extra precautions often required by alfalfa, the northern farmer recognizes clover as his best hay crop.

On the other hand, in parts of southern Wisconsin alfalfa grows like a weed. In other parts clover does not grow as it did when the land was new. It is often hard to get a stand of red clover. Some say the soil is ''clover sick,'' which nearly always means a lack of lime. Under these conditions, and especially where liming is practiced, alfalfa may prove a much more profitable crop because of its higher yield and greater permanence. A good stand of a hardy variety of alfalfa may last many years and abundant crops of hay can be obtained at no other expense than the initial cost of seeding and the annual harvesting. A crop like red clover, which usually lasts but one year after seeding, must be plowed and reseeded later in the rotation. Over a period of years much more labor in the way of frequent seed bed preparations is involved.

CROPS THAT WORK HARDEST FOR US

In this day of high-priced land and high-priced labor it becomes necessary for the livestock farmers to grow chiefly those crops that work hardest for them, those crops that produce the most and bring the greatest net returns for the labor and effort applied. In Wisconsin there are three crops which stand foremost in the production of feed per acre for livestock—alfalfa and clover, for hay; and corn, for silage. Here is a combination of crops, which, if grown successfully, cannot be beaten for home-grown feed for milk and meat production. The acreage of pure timothy in Wisconsin is about equal to that of alfalfa and clover combined, and yet timothy is the poorest producing hay and the poorest feeding hay grown on the farm. Timothy is all right in combination with either clover or alfalfa but as a straight hay crop it has no place on the average livestock farm in Wisconsin.

WHERE TO GROW ALFALFA

Choose a sloping soil. Avoid heavy flat land with a hard pan subsoil that does not permit good under-drainage. A mixture of timothy and alsike is the hay crop for such conditions. Alfalfa must have both good surface and good under-drainage. It likes a gravelly limestone subsoil best. Sometimes it grows well on rich bottom lands or on black flat prairie loams that have thorough under-drainage, but in certain years it will suffer severely from ice sheets and other winter injury on any flat ground. Better choose a sloping field.

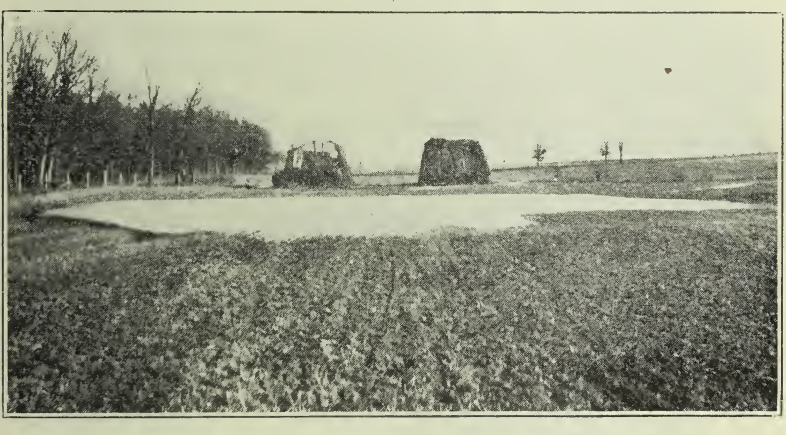

FIG. 4.—BEST TO CHOOSE A SLOPING FIELD

Flat lands will grow alfalfa but smothering ice sheets like this may cause winterkilling.

Select reasonably rich soil. It is a waste of time and money to attempt growing alfalfa on a worn-out piece of land. If the soil is not fertile, a good topdressing of manure and in many instances, an application of phosphate fertilizer, would help immensely to increase the yields.

''Lime, inoculation and manure make alfalfa doubly sure'' is particularly true on poor soils. On very thin, rocky limestone ground, sweet clover may prove much better than alfalfa, especially from the standpoint of building up the land. Sweet and red clover can be grown on poor soils without fertilization with a greater degree of success than alfalfa.

Newly cleared land or virgin soils may be fertile but on account of blue grass infestation and poor physical condition such ground should first be subdued by cropping a number of years with cultivated crops, such as corn or potatoes in rotation with grain and clover.

While some excellent results have been obtained with alfalfa on sandy soils it should not be recommended too strongly on the poorer sands. Special soil treatment in the way of liming, fertilization and rolling is nearly always required for success.

Use clean ground. To avoid weed trouble have alfalfa follow some well-cultivated crop like corn or potatoes. The use of a nurse crop which is cut early will often control the weeds the first season, but if they should get bad, clipping with a mower or grain binder about the middle of August will largely dispose of that difficulty.

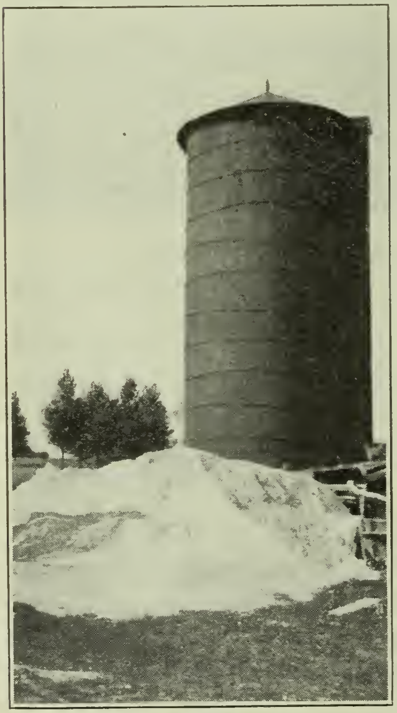

FIG. 5.—SIGNS OF PROGRESS

Lime for alfalfa; the silo for corn.

LIME—ALFALFA'S GREATEST NEED

Lack of sufficient lime in the surface six inches of soil is the greatest cause for failures, poor stands, and poor growths of alfalfa. Even soils of distinct limestone origin and formation are often too sour to grow alfalfa successfully. Rain, with the aid of cultivation and years of cropping, may have leached the lime out of the surface soil. Leaching and the removal of lime in crops taken off the land may have reduced the supply so much that a sour condition has developed, making the soil unfavorable to the growth of both alfalfa and clover. This condition is known as soil acidity.

Alfalfa is a lime-loving plant. Four tons of cured alfalfa remove 20 times as much lime from the soil as the straw and grain of a 30-bushel wheat crop. A ton of alfalfa hay contains nearly 100 pounds of lime. There is no crop grown on our farms which needs as much lime as does alfalfa. This explains why alfalfa does so well in southeastern Wisconsin, where the soil is, for the most part, underlain with a gravelly limestone subsoil. Even here the surface is often sour and liming proves necessary and profitable. On very fertile soils alfalfa will grow well even though the soil is quite acid. The greater the soil fertility, the smaller the amount of lime required.

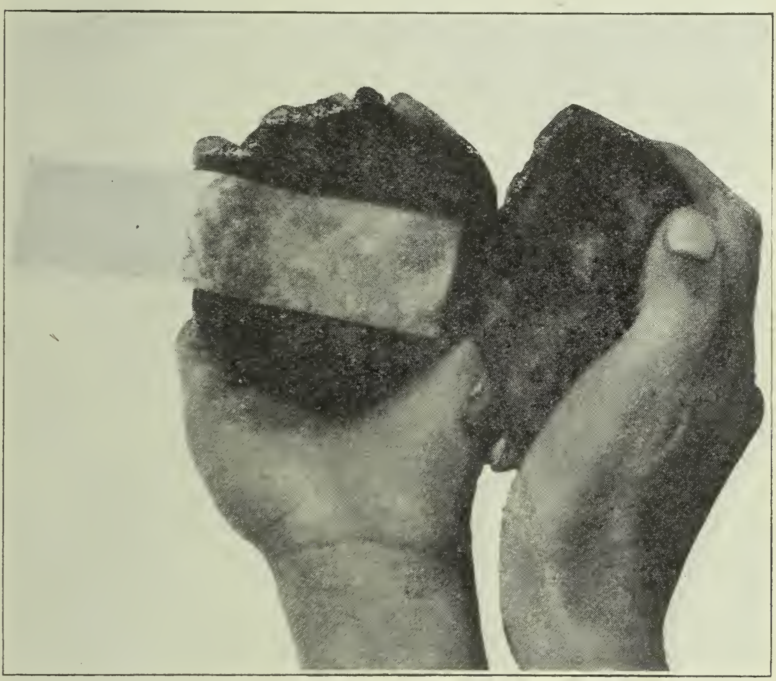

FIG. 6.—THE BLUE LITMUS PAPER TURNS PINK WHEN PLACED IN CONTACT WITH ACID SOIL

Make a ball of moist earth and break in two halves. Place litmus paper on one half and cover firmly with the other. If after five minutes the paper has turned pink in spots or pink all over the soil is sour.

HAVE YOUR SOIL TESTED

Not every field needs lime to grow alfalfa successfully. Some soils are abundantly supplied and need no further applications. Other fields may require as much as five tons an acre. The lime requirements of any soil for successful alfalfa growing can be determined easily by the Truog test. This test not only tells whether or not the land needs lime for success with alfalfa but shows approximately how much lime should be applied. It has, in a large measure, taken the "gamble" out of alfalfa growing. There is no need to take chances. Find out if your soil needs lime. Have it tested and save money. Get your county agent to do it or send a half-pound sample to your experiment station. They will let you know how much lime, if any, you should use for success with alfalfa. If your soil is sour and you are not in a position to get ground limestone or some suitable form of lime, better wait to sow alfalfa. Lack of lime has been the cause of thousands of failures in the way of sickly yellow starving alfalfa fields.

KIND AND AMOUNT OF LIME TO USE

The form of lime most generally used for agricultural purposes is ground limestone. It is cheap and quite readily obtained. In case of long hauls from freight stations farmers may cooperate in purchasing a portable lime grinder and doing their own grinding, provided a quarry of good limestone, containing not more than 10 per cent impurities, is available. Limestone samples are tested free by the Wisconsin Experiment Station and information rendered as to their value for grinding purposes.

Ground limestone may be used in several grades. Although the coarse form is cheaper, the finely ground product brings more immediate results with smaller applications. Generally from two to four tons to the acre are required, but the amount used should be gauged entirely by the fineness of the limestone and the results obtained with the soil acidity test. Better use too much than too little, as an excess does no damage and makes the application last much longer.

Marl is an excellent form of lime but is generally difficult to buy. Waste limes such as airslaked lime, and lime refuse from sugar beet factories and lime kilns, are good if bought right. As these by-products are often stored outside and are thus exposed to rain, it is important to know the moisture content before purchasing in any considerable quantity. This may also hold true with ground limestone.

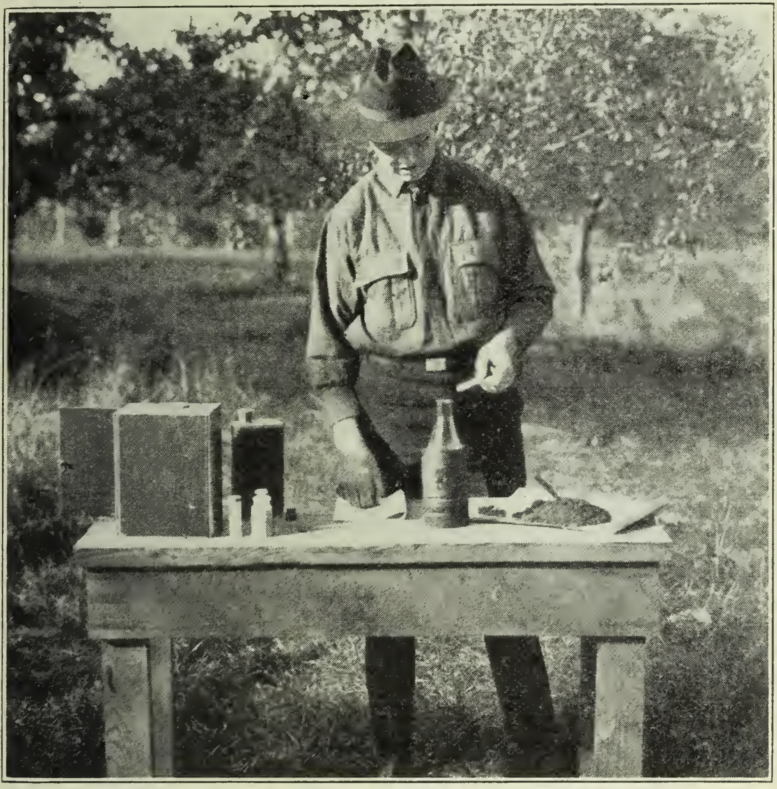

FIG. 7.—IT TELLS HOW MUCH LIME THE SOIL NEEDS

Truog's test not only determines the acidity of the soil but gives the amount of lime required to grow alfalfa successfully.

APPLY LIME ON PLOWED GROUND

Lime should always be applied to the surface of the plowed soil and then harrowed in. It may be applied in the fall, winter or spring. It should never be plowed under. Sandy soils are best limed in the spring, before seeding, as there may be some loss by leaching if such soils are limed in the winter or fall. Lime can be spread with a shovel directly from the wagon box on a still day. Lime refuse and other forms of damp lime are very conveniently spread in this way. Where large amounts are to be handled, lime spreaders are used to good advantage. The manure spreader, too, can be used for spreading lime. The apron needs to be covered with a few inches of manure or barnyard chaff and the machine set at the lowest speed, so as to distribute about four loads to the acre. The lime is then spread on this layer and enough hauled in each load to make the desired application.

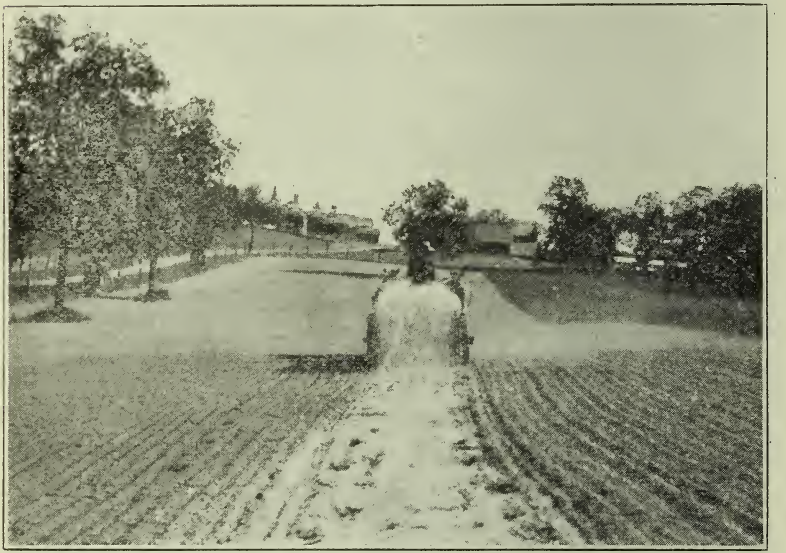

FIG. 8.—LIME IS CONVENIENTLY DISTRIBUTED WITH A MANURE SPREADER

This makes a convenient and efficient way of applying the lime.

As a top dressing ground limestone has not proved effective except on loose, open, sandy soils where the lime will work its way down where it is needed. In such cases it can be applied in the fall, winter or early spring. With heavier soils, lime applied to a plowed field and worked in when the seed bed is prepared gives more profitable results than lime applied as a top dressing any time after seeding.

MANY FIELDS NEED INOCULATION

Alfalfa is a new crop in Wisconsin. Where alfalfa has not been previously grown, the soil frequently requires the introduction of special bacteria before a successful stand can be obtained. Inoculation is the process of adding these bacteria to the soil or seed.

When the bacteria are present in the soil in limited numbers, the plants that are not acted upon by them often become weak and winterkill. This is especially true of poor soils low in nitrogen. In some sections of the state the ground is sufficiently supplied with alfalfa bacteria so that inoculation is not necessary, but there are many localities where the bacteria are present in such limited numbers that it seems impossible to get a good stand to survive the first winter.

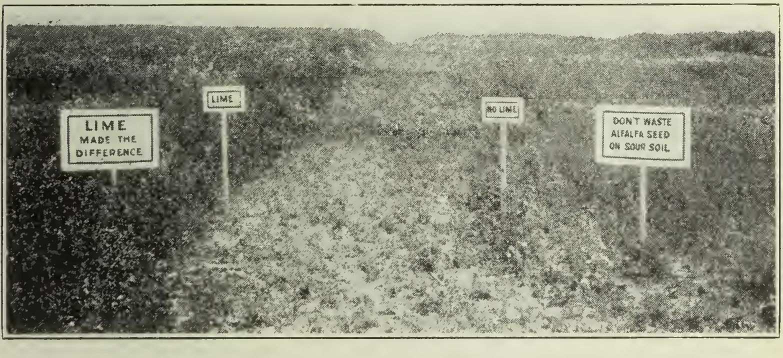

FIG. 9.—LACK OF LIME CAUSES MANY FAILURES

Thin stands and sickly yellow growths are often caused by sour soils.

Sweet clover, formerly regarded as an ordinary roadside weed in nearly all of the southern and eastern counties of the state, is one of the alfalfa bacteria distributers. Fields may be successfully inoculated by scattering upon them one ton of soil from an old alfalfa field or from land upon which sweet clover has grown.

A much more convenient method of inoculation is now possible since the bacteriology department of the experiment station has been furnishing farmers with cultures at the cost of preparation. One bottle is sufficient to treat the seed for one acre. Excellent results have been obtained with the culture and farmers over the entire state are taking advantage of this helpful service.

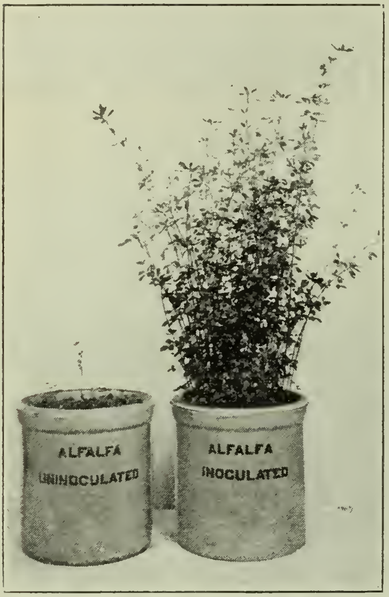

FIG. 10.—INOCULATION OR STARVATION

Each jar contains pure quartz to which all the necessary elements for plant growth, except nitrogen, have been added. The alfalfa bacteria supplied by inoculation have taken sufficient nitrogen from the air to produce a healthy growth of alfalfa. The alfalfa plants in the sand receiving no inoculation have starved for want of nitrogen. Especially on poor sandy and other infertile soils, which may lack nitrogen, inoculation is very important.

A good scheme to get the entire farm inoculated for future crops of alfalfa is to use two pounds of inoculated alfalfa seed an acre with every grass and clover seeding. The scattered alfalfa plants serve as distributers of the alfalfa bacteria in the soil and at the same time improve the quality of hay.

A FIRM SEED BED BEST

The principal factor in getting land ready for alfalfa is to have a firm seed bed with the lumps on the surface well broken up. Fall plowing for heavy soils gives time for the land to settle and develop the proper firmness. Alfalfa sown on spring plowed ground, and especially on loose sandy soils that always require spring plowing, is benefited by rolling with a corrugated roller. Rolling aids clover, also, and brings better yields of grain. In general, no farm implement helps to prepare a better and more economically prepared seed bed than does the corrugated roller.

SPRING SEEDING MOST SUCCESSFUL

There are many ways of growing alfalfa but the outstanding method used in Wisconsin is to spring-sow with grain. The greatest dangers which attend this method are that lodged grain will smother the seeding, and severe drought following the removal of the grain crop may ruin the stand. These difficulties are effectively overcome by cutting the nurse crop for hay just after it is headed out, an important precaution where summer drought causes loss to clover or alfalfa seedings. It gives the alfalfa a good growing start before the dry weather approaches and enables it to withstand the attacks of summer drought and grasshoppers later on. Where grain is allowed to ripen, early maturing varieties should be used, such as Kherson oats (Wisconsin No. 7) or pedigreed barley. Avoid spring wheat or late oats as these grains remain on the soil too long. Grain should be sown at the rate of not more than one bushel an acre to avoid crowding the alfalfa too severely.

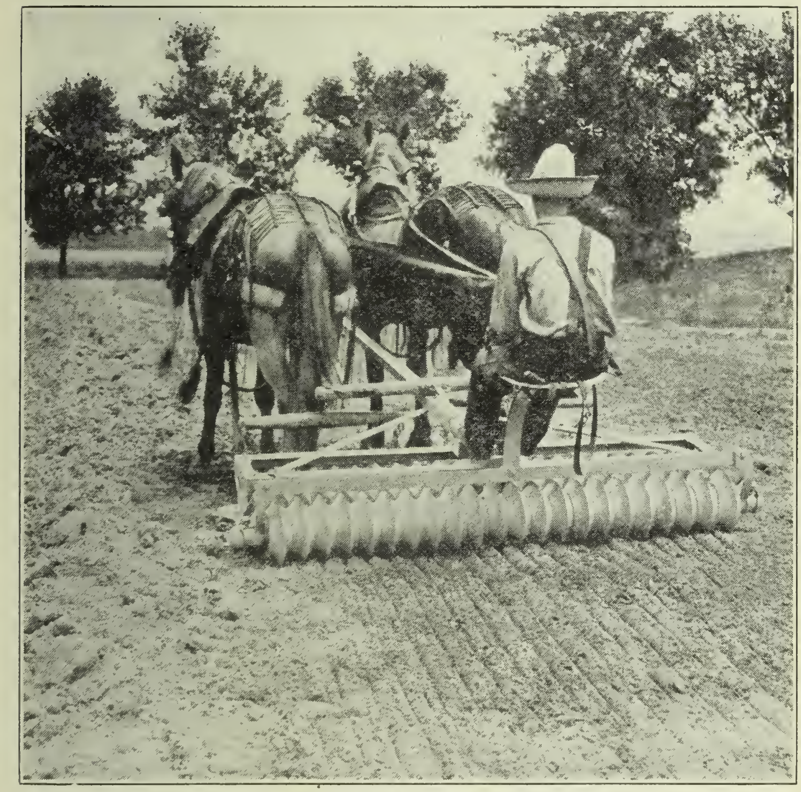

FIG. 11.—PREPARE A GOOD SEED BED

The corrugated roller breaks coarse lumps, firms the seed bed, and leaves the surface loose.

Canning peas make a very desirable nurse crop for alfalfa, primarily because of their very early harvesting period. The particular advantages of sowing alfalfa with a nurse crop come from the prevention of soil washing, the checking of weed growth, and returns from the soil in the form of grain or forage the first year.

Winter wheat and winter rye are sown in September, which is too late for alfalfa. These grains may be used as nurse crop with some degree of success by sowing the alfalfa early the next spring before the frost is out of the ground and preferably on top of the last snow. When clay or loam soils thaw out they become honeycombed with cracks and small crevices which later close up and cover the seed. On lighter soils this does not occur so effectually, and harrowing in the seed is necessary, a practice in no way harmful to the growing rye or wheat. While alfalfa seed, like clover, is not injured by being seeded on snow or frozen ground and germination occurs with the onset of warm weather, this method seems to give much better general success with clover than with alfalfa.

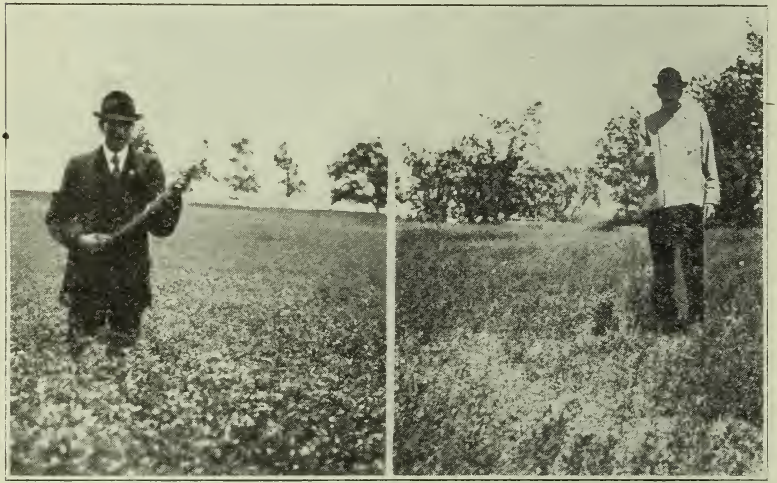

FIG. 12.—A THIN NURSE CROP FOR THICK ALFALFA

The good stand was seeded with one bushel of barley an acre while the poor stand was seeded with three bushels of oats to the acre.

Seeding Alfalfa Alone

One of the surest but most expensive ways to sow alfalfa is to put the soil through a careful weed-killing process by disking and harrowing at frequent intervals and seeding alone in May or June. If the soil is extremely weedy the cultivation should be continued until early in July. Where danger of soil washing is serious this method should never be used. While this plan involves elaborate soil preparations it has its advantages in eliminating the weed difficulty and in giving time for such soil treatment as liming, manuring and fertilization. On sandy soils, where there is not too much danger of soil blowing, it is an ideal way to get a good stand. The average sandy land will not produce sufficient growth of alfalfa when sown with a nurse crop to withstand the summer's drought unless the nurse crop is cut for hay and only two or three pecks of seed used to an acre. The principal value of a nurse crop for alfalfa on sandy soils is to prevent soil blowing.

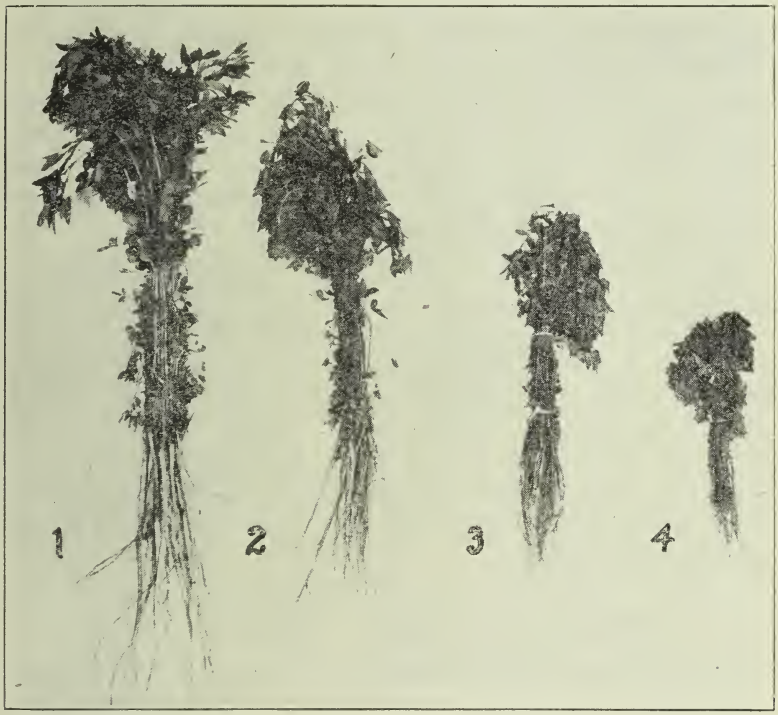

FIG. 13.—LATE SUMMER SEEDING IN WISCONSIN REDUCES VIGOR OF GROWTH THE FOLLOWING SPRING

Date Seeded 1914	Length of Roots May 12, 1915, Inches	Length of Stems May 12, 1915, Inches
August 4	20	20
August 25	13	17
September 15	10	13
September 25	8	8

Crops like early potatoes and canning peas are harvested early in the summer and the soil can be disked (not plowed) and harrowed in good shape for July seedings of alfalfa with excellent chances of success. This seeding practice, however, nearly always fails with grain crops, which are harvested so much later. They dry out the soil and quite generally drought follows their harvest, making almost impossible the seed bed preparation with disk or plow.

Late summer seedings are always risky. If abundant rains and warm growing weather occur, seeding the last of August may prove successful, but this would be exceptional. Alfalfa should have a growth of from 6 to 8 inches before freezing weather occurs, which means that it is always safest to sow alfalfa not later than the month of July.

Seeding alfalfa in corn at the last cultivation has given success in many instances, and yet it can hardly be termed a safe way to sow the crop. With abundant rainfall and ideal soil conditions it gives excellent success. An inter-row seeder can be used, or an experienced sower can spread the seed by hand or with the use of a whirling seeder. Unless care is taken the latter two methods may result in an uneven stand. The corn is cut for silage or fodder and unless the stubbles are harrowed down the following spring they may cause considerable trouble with the first cutting.

MUST HELP YOUNG ALFALFA CONTROL WEEDS

With all due credit to alfalfa as a weed fighter it must be stated that during the first six months of its growth it is helpless in controlling the too numerous common weeds of the farm, such as foxtail, pigweed, and lambsquarter. A thin growth of these common weeds during August need not cause concern but a heavy, tall growth may crowd out the alfalfa. In the latter case, clip with a mower or binder as close to the ground as the height of the alfalfa will warrant. In other words, cut as little of the alfalfa and as much of the weeds as possible. Haul the clippings off before they smother the plants beneath. Attend to this in August. Late fall clipping, cutting or pasturing are dangerous to a new stand of alfalfa and bring on winter-killing.

MANURING NEW SEEDINGS DANGEROUS

A light application of fine, well-rotted manure is desirable for the first year's growth. Ten tons of rotted manure to the acre as a topdressing to a plowed field and disked in will do much to insure a good stand of alfalfa, but ten tons of straw manure applied to a new seeding of alfalfa the first fall may smother out some of the plants and thin the stand. After alfalfa has passed its first winter it is not so sensitive to smothering, however, and applications of six to eight tons of rotted manure an acre will prove a wonderful help to the next year's yields.

RATE OF SEEDING VARIES

The amount of seed required for a good stand is dependent upon the quality of seed, the care with which the seed bed has been prepared, and the condition of the soil in regard to lime, inoculation, drainage and fertility. Where alfalfa is easy to grow, less seed is required than where difficulty is experienced in getting good stands. Under our humid conditions, which give weeds and blue grass more than a fair start, heavy rates of from 15 to 20 pounds of high-quality alfalfa seed may be required. This is very well shown by a cooperative experimental test made by 180 Wisconsin farmers, members of the Alfalfa Order, who for a period of three years compared 10- and 20-pound rates of seeding. Eighty-one per cent of these practical farmers reported that blue grass and weeds gave much more trouble with the 10-pound rate and that the 20-pound seeding gave a larger yield of finer-stemmed alfalfa and consequently a hay of much better quality.

In answer to the question, "Which is the best rate of seeding on weed-free, not acid, inoculated, and carefully prepared soil?" these replies were received:

47 per cent declared for 20 pounds an acre
36 " " " 15 " " "
17 " " " 10 " " "

Even under excellent soil conditions the farmers' verdict is in favor of the 15- and 20-pound rates, but when alfalfa was seeded for the first time, under average farm conditions and with the seed bed fairly well prepared but somewhat weedy, the replies were decidedly for the heavy seedings:

91 per cent declared in favor of 20 pounds an acre
7 " " " " " 15 " " "
2 " " " " " 10 " " "

Naturally, the farmer would prefer the 10-pound rate because of the lower seed cost, but in spite of this his judgment is for double the amount, especially for those beginning alfalfa growing. This should not convey the impression that a few extra pounds of seed will make up for a poorly prepared seed bed, but it does mean that weeds and blue grass necessitate heavy seeding for the farmers of Wisconsin.

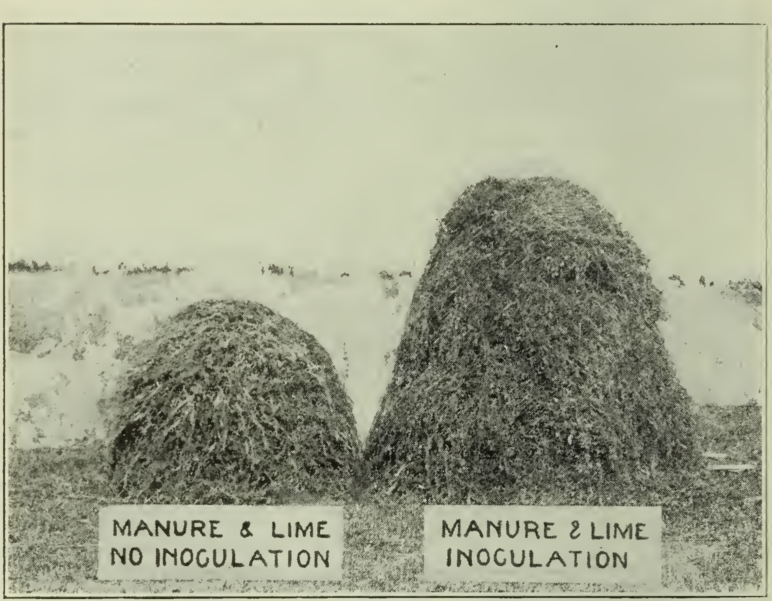

FIG. 14.—CONVINCING EVIDENCE OF THE VALUE OF INOCULATION

Manure and lime, with inoculation, yielded 2,500 pounds alfalfa an acre. Manure and lime, with no inoculation, yielded 1,180 pounds alfalfa an acre.

Sometimes alfalfa and clover may contain a high percentage of seed which, because of their hard impenetrable surfaces, do not sprout quickly. This condition is quite effectively overcome by a process of scratching or scarification which frequently enables the seed to germinate immediately. Scarified seed usually costs more than an identical lot not scarified, but it is worth more.

TIMOTHY AND ALFALFA GROW WELL TOGETHER

Four years' experience and experiment have demonstrated the value of sowing alfalfa mixed with one-fourth timothy. Under ordinary conditions this would mean a mixture of 5 pounds of timothy and 15 pounds of alfalfa per acre. If a good stand is obtained, the first cutting in the year following the seeding will be mostly alfalfa, with a uniform sprinkling of timothy just heading out. At this early stage timothy has a fairly high protein content and good palatability and feeding value, especially when grown in combination with alfalfa. The second and third crops will be pure alfalfa, as the timothy makes little recovery in growth after the first cutting.

The chief advantage of the combination is evident when winterkilling occurs. Instead of letting weeds and blue grass take the place of the dead plants where the alfalfa is thinned out badly, the timothy thickens and spreads out quickly, growing remarkably well on the decaying dead alfalfa roots.

In a four-year old plot of alfalfa and timothy on the experiment station farm over 50 per cent of the alfalfa killed out the second winter. In the two years following these plots averaged 6,850 pounds an acre in two cuttings. There was absolutely no trouble with blue grass, the much hardier timothy having taken the place of the dead alfalfa plants where the alfalfa was seriously winterkilled. On the upper end of the plot where winterkilling was not so serious, the timothy was less and the alfalfa much more abundant. Thus, the two crops are ideally adapted for combined growth. Where alfalfa thins, the hardier timothy thickens, but where the alfalfa remains thick the timothy keeps thin. This is one way of solving the winterkilling problem.

CAUSES AND REMEDIES OF WINTERKILLING

Alfalfa, like clover, winterkills. It is not necessarily the cold winters with extremely low temperatures that do the damage. It is the open winters, with little or no snow for protection against alternate freezing and thawing, which may cause heaving of the plants or fatal injury to the crowns, or both. Oftentimes the crown and root tissue are only partially killed, in which case the stand may not be seriously thinned but the feeding system of the plants becomes so weakened that the field has a sickly yellow growth and poor yields are obtained. Under these conditions the second and third growths may be much healthier and more vigorous than the first cutting because the roots and crowns have had time to recover from the winter injury. This is particularly true if favorable growing weather occurs during the summer months.

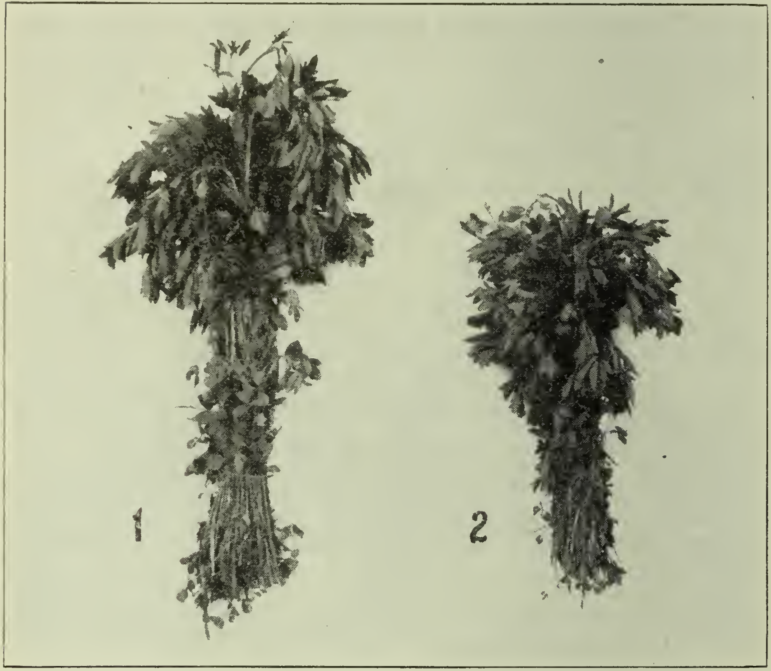

FIG. 15.—LATE FALL CUTTING WEAKENS ALFALFA

The vigor and rapidity of spring growth is seriously impaired following late fall cutting or pasturing.
Sample 1, Cut September 2, 1914. Height May 12, 1915, 22 inches.
Sample 2, Cut September 26, 1914. Height May 12, 1915, 17 inches.

A poor, sickly, yellow growth of alfalfa is often said to be due to improper soil conditions, whereas the trouble may be due entirely to the severity of the previous winter. Flat lands are affected worst of all. On them the water from melting snow or spring rains accumulates, and when cold weather comes smothering ice sheets put an end to the alfalfa plants beneath. These are discouraging facts which apply not only to alfalfa but to clover and our winter grains, wheat and rye. The best remedy is to avoid late fall cutting and pasturing.

AVOID LATE FALL CUTTING AND PASTURING

Some winters are so favorable that even with late fall cutting or pasturing alfalfa may not be seriously injured, but this is the exception rather than the rule. Alfalfa should have eight inches of fall growth to hold the snow for winter protection. In view of the frequency of killing winters it is poor policy to take a chance on cutting or pasturing alfalfa after September 10, as this practice makes alfalfa liable to winter injury.

But it still remains true that even where every regulation for growing or handling alfalfa has been carried out it may winterkill. Where this is of frequent occurrence the only solution of the difficulty is to use seed of the hardiest known varieties.

There is all the difference in the world between various kinds of alfalfa. Strains such as the southern Peruvian are very sensitive and will kill out with our mildest winters while other varieties may weather the hardest winters and be ready for business the following spring. This does not mean that any variety of alfalfa is absolutely winterproof, but it does mean that there are some kinds far superior to others in their ability to withstand severe open winter weather.

VARIETIES THAT ARE AND ARE NOT HARDY

Most of the alfalfa seed used in Wisconsin is of the common purple-flowered, western-grown variety generally sold as Montana-, Kansas-, or Dakota-grown, depending upon the state in which it was produced. It is an excellent variety, fairly hardy and a good producer, with an erect and upright habit of growth which is desirable. There is a preference for common alfalfa seed from the northern states because northern strains are claimed to be hardier. In a measure this claim is true.

Tests conducted with 16 samples of common seed from growers in New Mexico, Arizona, and California show conclusively that common seed produced in these states is, on the average, decidedly less hardy and more liable to winterkilling when grown in Wisconsin than Kansas seed or common seed produced farther north.

On the other hand, trials made with 40 samples of Kansas- and Nebraska-grown common seed in comparison with 20 samples of Montana- and South Dakota-grown seed practically indicate that they are about equal in hardiness. It must be borne in mind that these tests have plainly shown a distinct variation in the hardiness of alfalfa from seed produced by different growers in the same state and even in the same locality. For example, we find an occasional grower in New Mexico whose common seed produces alfalfa that is much hardier than that of another grower in the same locality. Likewise, we find an occasional grower in Montana whose common alfalfa is much more tender than that of the average for that state.

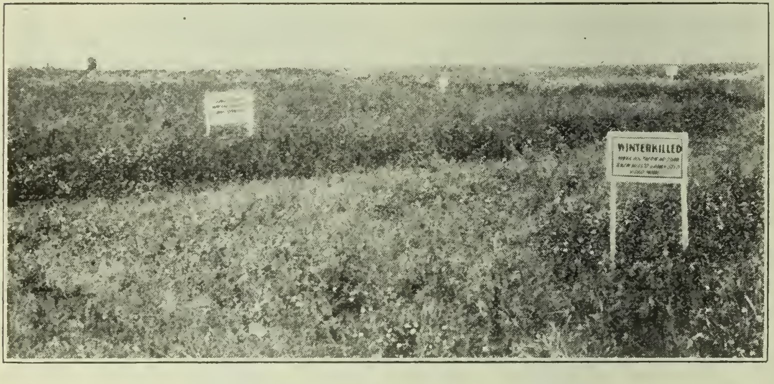

FIG. 16.—SOUTHERN SEED LESS HARDY

Alfalfa from common seed grown in New Mexico, Arizona and Southern California is more liable to winterkilling than the hardier strains from Kansas, Nebraska, and states farther north.

These facts should in no way encourage Wisconsin farmers to buy high-priced common seed with a fancy name attached and for which special claims of hardiness are made. Some strains said to have originated from very old fields in the West often command an extra premium in price. Our trials with these strains have, with a few exceptions been unsatisfactory.

GRIMM, BALTIC AND COSSACK MOST RESISTANT

The most winter-resistant alfalfas thus far found for Wisconsin conditions are the Grimm, Baltic and Cossack. Experience and experimental evidence is much more abundant on the superiority of Grimm and Baltic than it is with the Cossack, but our tests with the latter variety have, so far, been favorable. Grimm is by far the most widely grown and the seed is more readily obtainable than that of either the Cossack or Baltic alfalfa. However, the acreage of Cossack is being rapidly extended in the seed-producing sections of the West. The only characteristic which makes these alfalfas superior to the common is their extreme hardiness, which makes them more permanent in stand than common alfalfa and better yielders where the common strains winterkill.

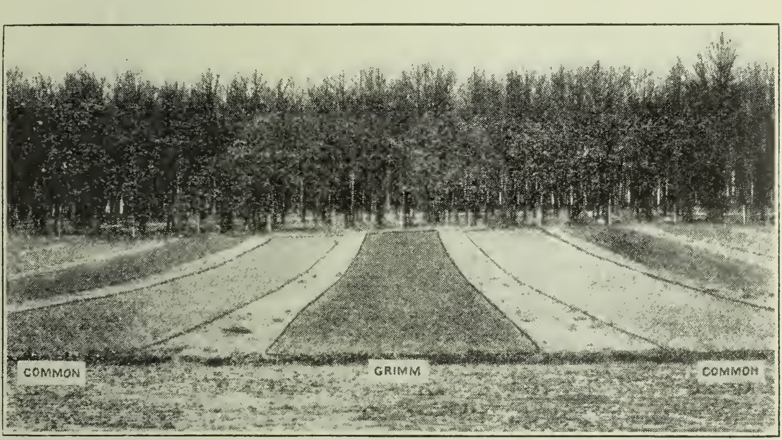

FIG. 17.—VARIEGATED STRAINS HARDIER THAN COMMON

Following hard winters Grimm, Baltic and Cossack grow more vigorously and show less winterkilling than common alfalfa.

Hard to Get Genuine Seed

The good qualities of Grimm, Baltic and Cossack alfalfa are often severely discounted because of the difficulty of getting genuine seed. No one can distinguish the seeds of any of these varieties from those of common. The result is that growers and seedsmen may intentionally or unintentionally sell common seed for the much higher-priced Grimm, Baltic or Cossack, or they may adulterate these hardy varieties with cheaper seed. This makes the purchase of any special alfalfa very difficult and the greatest of care needs to be exercised. Unless these varieties can be secured from reliable sources and with affidavits of genuineness from both the grower of the seed and the seller, giving full pedigree and origin of the seed, it is probably wise to grow common alfalfa. The Alfalfa Order has been testing out hardy seed of all varieties from numerous western growers and other sources.

HOW TO DISTINGUISH HARDY VARIETIES IN FIELD

Grimm, Baltic and Cossack are quite similar in manner of growth and field appearances. They are often classed as variegated alfalfas because, when they come into full blossom, they have a considerable percentage of mixed colored flowers ranging all the way from white, light yellow and green to smoky hues of brown, purple and blue. This condition is particularly outstanding in the Cossack variety, but it should be remembered that most of the blossoms of the three kinds are pure purple and similar to common. It is only when the plants bloom abundantly that variegated alfalfas can be distinguished from common by flower characteristics. Quite often common alfalfa has some variegated flowers but seldom are they found in such abundance as in the true Grimm, Baltic, and Cossack. It should be particularly understood that where the varietal term "variegated" is used in this bulletin it refers only to the Grimm, Baltic and Cossack.

TABLE 18.—GENUINE VS. NON-GENUINE SEED

It is difficult to get genuine true-to-name seed of the hardy varieties.

At the cutting stage it is often noticeable that the variegated alfalfas have a darker green foliage, a denser growth and a greater tendency to lodge than the common kinds. Following hard winters the variegated varieties, in addition to manifesting less winterkilling, often show a much more rapid early spring growth than the common. On the other hand, the fall growth of the variegated alfalfas is often noticeably shorter than that of common. Like almost all hardy alfalfas, after the third cutting they develop a protective dormant condition in preparation for the oncoming winter, while the common, with favorable weather, may make a rapid and tall fall growth. Oftentimes the variegated alfalfas do not grow so tall the first season as does the common.

Evidence from members of the Alfalfa Order shows plainly that the Grimm variety is more liable to injury by summer drought the first season than is common. Six reports stated that Grimm seeded adjacent to common dried out the first season and was a complete failure while the common brought forth an excellent stand with the onset of fall rains. This probably applies to the Baltic and Cossack also.

Considerable credit has been given to the so-called branched root system of the hardy variegated varieties. This has led to the popular belief that all plants of common are taprooted, and that all plants of Grimm, Baltic or Cossack have distinctly branched roots. This opinion is entirely mistaken and not in accordance with the facts. Common alfalfa from the western states will have both branched roots and taproots when grown in Wisconsin, and such is exactly the case with Grimm, Baltic or Cossack. The percentage and degree of branching in the latter three varieties, however, are greater than in the common.

Another difference in the variegated alfalfas and the common strains, which is not very noticeable except on close comparison and inspection in thin fields over one year old, is the greater size and more widely branched character of the crowns of the Grimm, Baltic and Cossack. In both spring and fall the growth of the stems and leaves of these varieties is likely to be more squatty and spreading in appearance than the more erect growth of the common.

It is important to appreciate that these distinguishing characteristics of variegated and common alfalfa are only manifested during times of certain climatic conditions. With an overabundance of rain or in extreme drought, variegation of the blossom may not be evident, due to a lack of sufficient bloom.

Likewise, after mild winters the spring growth and stand may be identical with common.

It is quite evident that distinguishing hardy variegated varieties from common alfalfa is not an easy matter under field conditions in Wisconsin. If the two kinds are sown side by side at the same time and in the same way, the variegated variety should show its superiority in hardiness following the advent of a hard winter. To ascertain the reliability of any source of hardy seed it may be wise to seed a small strip of common for comparison. It is important to realize, however, that neither Grimm, Baltic nor Cossack are absolutely winterproof, and under certain conditions they will winterkill, though seldom, if ever, to the same extent as common.

NEW SEEDINGS OF COMMON ALFALFA ARE HARDY

In order to avoid disappointment to those who may try out any or all of the three variegated varieties in comparison with common, the writers wish to emphasize that there may be little difference in yields and general appearance the first year after seeding. It is only under unusually severe winter conditions that the variegated will demonstrate its superiority in a one-year trial. It is a strange fact that average common alfalfa from Kansas and states farther north is much hardier the first winter than at any time later in its career.

An example of this fact is shown in a test on the experiment Station farm where a plot was seeded on June 23, 1915, with Montana-grown alfalfa in the same manner, under the same soil conditions, with the same strain of seed (taken out of the same bag) as a similar plot not more than three rods distant, which was sown June 27, 1914. Both these plots had excellent stands in the fall of 1915, but in the spring of 1916, 76 per cent of the plants in the two-year old plot had winterkilled while of the new seeding only 9 per cent had winterkilled.

Just why old stands of common alfalfa winterkill more seriously than new seedings is difficult to explain, but that it is a fact is further supported by 165 reports from members of the Alfalfa Order in 1916, three-fourths of whom declared their old stands winterkilled much worse than the new seedings of 1915. Results like this would indicate that where alfalfa is grown instead of clover in three- or four-year rotations the high-priced hardy Grimm, Baltic and Cossack may not, in many places, be essential. These varieties are primarily of value where permanence of stand is desired.

WHEN TO CUT ALFALFA

No exact date can be given for the first, second or third cuttings but a good indication to follow is the growth of the little shoots or sprouts originating at the crowns. When the field begins to bloom quite abundantly an examination at the base of the stems will show little sprouts that later produce the next crop. When these are very numerous and at least an inch in height the cutting time is at hand if there is favorable curing weather. If not, harvesting can be delayed until fair weather occurs. Where the delay is not too long no injury to the stand or growth of the next crop will occur but only two cuttings may be obtained. This is less serious than the harm which accompanies cutting alfalfa too early and which often causes such a serious thinning of the stand that weeds and blue grass take possession of the field. Cutting too early may also result in a weak, short, yellow succeeding growth and a shorter-lived alfalfa field. Better have the first cutting too late than too early. Avoid close cutting. Leave a stubble of about two inches.

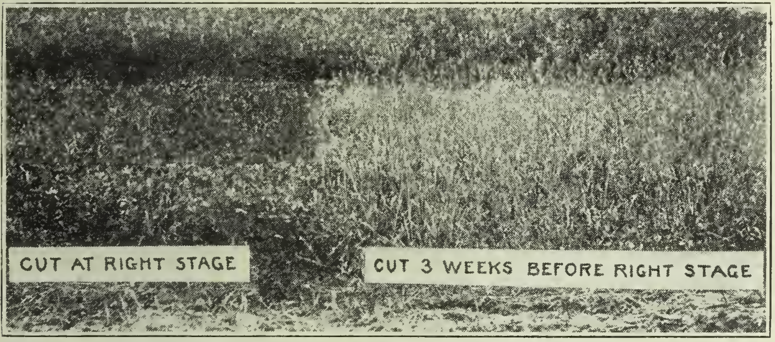

TABLE 19.—CUTTING TOO EARLY KILLS

Cutting alfalfa too early is bad. The succeeding growth is often yellow and so severely checked that weeds and grasses spring up and choke out the alfalfa.

In favorable seasons, three crops of alfalfa may be obtained, but as a protection against winterkilling the last crop should not be taken after September 10. On farms with large acreages only two cuttings are planned for, on account of the difficulty of cutting all the alfalfa at the right stage. With smaller acreages three cuttings can often be taken to good advantage.

NEEDS THOROUGH CURING

To get the best quality of hay, alfalfa should be cut on a day that promises to be fair. Do not, under any circumstances, plan to leave alfalfa cure in the swath, like timothy. At least half the feeding value of alfalfa is in the leaves. With their thin and much exposed surfaces they dry out quickly, become brittle, and are lost in handling. To get alfalfa or clover hay cured uniformly and with the least loss of leaves the crop should not remain in the swath longer than is necessary to become well wilted. This may require four or five hours after cutting in hot dry weather, or one or more days if the weather is cool, damp or cloudy. The wilted hay can be raked and bunched without serious loss of leaves into cocks of about 100

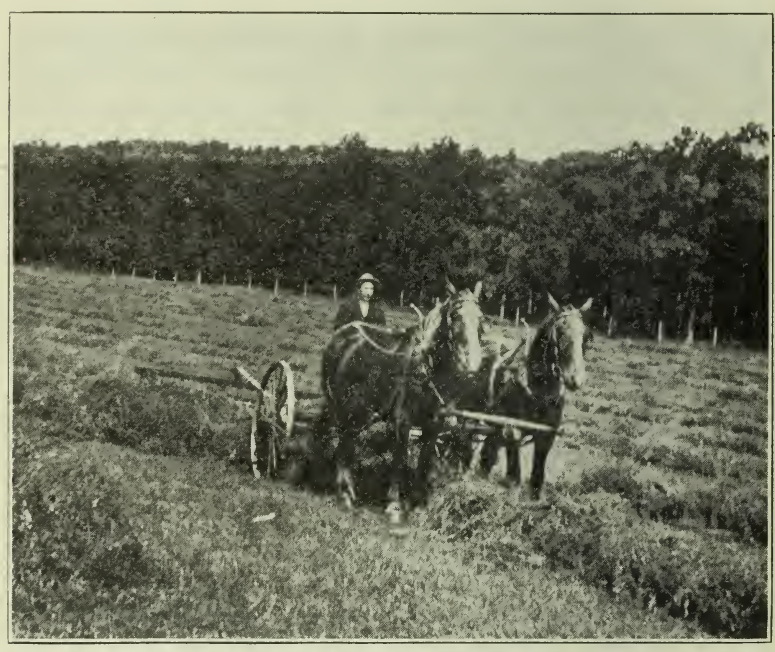

FIG. 20.—CURING IN WINDROWS SAVES LEAVES

Alfalfa hay is readily raked into windrows with side delivery rakes.

pounds each. Larger cocks may heat and mold in the center. Under no circumstances should alfalfa hay, damp with dew or rain be bunched, raked or stored. Outside moisture of this nature will invariably cause molding, or severe heating, or both.

Given favorable drying weather alfalfa will be ready to store two days after bunching. In cool, damp weather the curing process may require a week, in which case the bunches may need to be moved in order to give the plants beneath a chance to grow. Canvas caps, while not so popular now as they used to be in the days of small alfalfa acreages and more abundant labor, are a wonderful protection against rain. An hour or so before loading the cocks should be spread apart and opened to the wind and sun to free the interior from any surplus moisture.

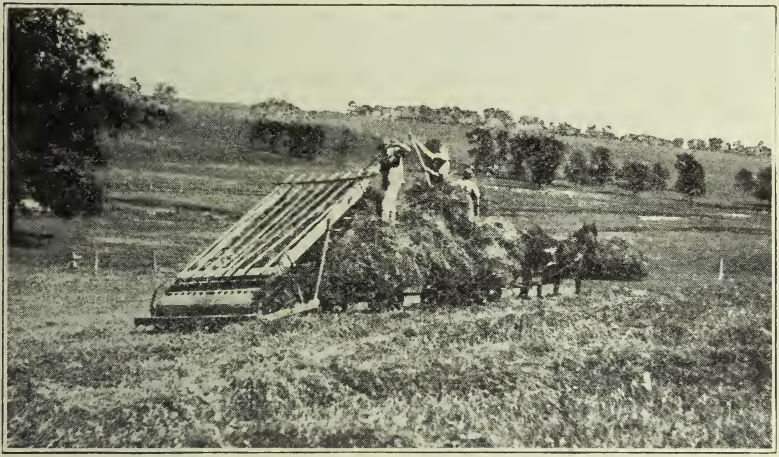

FIG. 21.—HAY LOADERS FOR HASTE

Alfalfa hay is readily handled with labor-saving machinery.

The hay is then ready to be loaded with a drum hay loader or pitched by hand. With this method the brightest green hay is obtained with the least loss of leaves. The curing process which goes on in the bunches is uniform, since the life processes of the wilted plants continue and the moisture moves up the stems and is passed off through the leaves. However, with the scarcity of farm labor, farmers having a considerable alfalfa acreage prefer to take risks on the weather for the sake of employing less hand labor and more rapid haymaking machinery.

SIDE DELIVERY RAKES FOR WINDROWING

One plan of alfalfa haying is to allow the cutting to wilt in the swath, after which it is raked in windrows with a side delivery rake. Here it is left to cure out thoroughly, but a few hours before loading with a hay loader the windrows are turned bottom side up with a side delivery to allow the hay next to the ground to dry out. If no rain occurs an excellent quality of green hay is secured. In the event of rain the windrows are turned several times after fair weather returns to permit thorough drying. This, of course, ruins the green color of the hay and, to some extent, its feeding value, but experience has demonstrated that alfalfa will stand much more rain than either timothy or clover and still make good hay.

BROWN ALFALFA HAY

Alfalfa thoroughly cured in the field will maintain its bright green color when stored in the mow or stack. When it is stored while still a little green, the stems contain a considerable amount of plant juice and heating and fermentation occur in the stack, resulting in a very aromatic and palatable brown hay. It is sometimes advisable to store alfalfa before it is thoroughly cured, but as a precaution against excessive heating and molding it is well to distribute the hay at the time of storage over several bents in the barn, instead of piling it high in one mow.

It must be remembered that it is positively dangerous to store any alfalfa hay if it contains moisture from dew or rain. Spontaneous combustion resulting in fires may occur, or at the least, there may be a molding and charring which injures the feeding value of the hay. The interior moisture of the stems and leaves of ordinarily cured hay will not, as a rule, cause this difficulty. It is the outside moisture on the hay at the time of storing that is particularly dangerous.

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Bulletin 309 December, 1919

MARSH SOILS

A. R. WHITSON
H. W. ULLSPERGER

AGRICULTURAL EXPERIMENT STATION
THE UNIVERSITY OF WISCONSIN
MADISON

DIGEST

Marsh lands in Wisconsin vary in agricultural value. To know which classes of marsh lands are valuable, which can be drained, and those which are capable of high production after draining, are the problems facing the farmers who own the marshes of Wisconsin. Page 3.

The steps necessary to reclaim marsh soils are: drainage, breaking and preparing the seed bed, proper fertilization, and crop selection. Each of these is important to the marsh farmer's chance for success. Pages 3 to 7.

Different marsh soils require different fertilizers. The soils differ in chemical composition and require different kinds of fertilizer. A chemical analysis is helpful, but actual experiment is often needed to find out what fertilizers should be applied. Pages 7 to 18.

A wide variety of crops can be grown on Wisconsin marsh soils. The number of crops which can be grown is limited at first. Soybeans, buckwheat, and flax are the best first crops in middle and upper Wisconsin. Corn and rye are often grown in southern Wisconsin as first crops. Pages 18 to 25.

Crops should be adapted to marsh soils in different sections of the state. There are three such sections: southeastern Wisconsin, the light soils area, and north central Wisconsin. Pages 25 to 28.

Crop rotations are desirable on marsh soils. They make for higher yields and aid in preventing insect pests and crop diseases. Pages 28 to 29.

Dairy farming, truck farming, stock raising, or combinations of the three are the best types of farming to follow on marsh soils. Wisconsin marshes are not adapted to grain farming. Pages 29 to 32.

Farming Marsh Soils

Five factors determine largely whether or not it will pay to drain and farm marsh land. These are: (1) the cost of thorough drainage, (2) the cost of clearing and breaking, (3) the chemical composition of the soil, (4) the danger of frost during the growing season, and (5) whether the farm is all marsh or partly upland.

Thorough drainage usually costs from $20 to $35 an acre. Clearing and breaking cost between $5 and $25 an acre, depending largely on whether the marsh is open or timbered.

Marsh lands vary greatly in their chemical composition—some need only to be drained to grow good crops while others require special treatment.

Marsh soils are subject to frost, which lessens their adaptability to corn and potatoes in the central part of the state and prohibits success with these crops in the northern counties.

When a farm is all or nearly all marsh it is imperative to drain thoroughly a portion of it, if not the entire acreage. On many farms having comparatively small marsh areas drainage is often overlooked because there is sufficient upland to meet the cropping needs and the marsh is left as pasture. Whenever the returns of such pasture lands are carefully considered, it becomes plain that they would prove much more profitable if made to grow "tame" crops of *high* feeding value rather than wild grasses of *low* feeding value.

In the southern part of the state it will pay, as a rule, to drain all mucks and shallow peats having clay subsoils. Well-decomposed peats underlain by clay are much better than raw peats. Raw peats underlain by sand are of less agricultural value.

How to Manage Marsh Soils

In managing marsh soils four important factors must be considered: (1) drainage, (2) preparation of the seed bed, (3) use of manure and other fertilizers, and (4) selection of the proper crops.

Drainage the First Step. The first step in the development of any marsh land is to drain it. In case of extensive areas large main ditches requiring the use of a dredge must be dug. For this purpose it is necessary that land owners cooperate by organizing a drainage district or by having the county drainage board take charge of the work. In case of smaller areas it frequently can be done by mutual agreement between two or three adjoining owners.

Both Surface and Under Drainage Needed. Sometimes the construction of ditches around the edge of a marsh tract will reduce the wetness of the marsh so that crops can be grown without further ditching. Where the offending water is seepage a deep, rather than a large, drain is necessary, and in such cases tile are cheaper than open ditches. These cut-off drains carry away the water from the surrounding higher land, and thus prevent it from reaching the marsh. Usually both ditches and tile are necessary on the marsh itself.

Tile Are Better Than Surface Ditches. When the surface soil is peat or muck three feet or less in depth and underlain by sand, small open ditches eight rods apart will sometimes give sufficient drainage for most crops. But when the subsoil is clay the laterals must not be more than six rods apart, and in some cases less, to give thorough drainage. Under these conditions tile should always be used since they give better drainage than the open ditches. Another advantage of tile is that they are covered so that they do not interfere with the tillage of the land. In cases where the peat or muck is three and a half feet or more in depth, tile should be used and should be placed quite deep—from three and one-half to four and one-half feet. This is done for two reasons,—the settling of the surface will not bring the tile too near the top of the ground, and a wider strip of land can be drained by each line of tile.

Tile Make Cultivation Easier. The use of tile makes it possible to do away with open ditches, and makes the land easier to cultivate. Because muck and peat lands usually shrink and settle considerably when drained, it is often desirable to use open ditches for three or four years. These may, in some instances, be left for surface drains, or they may be filled when new ditches for the tile are dug beside them. Experienced drainage men usually prefer digging new ditches to cleaning out old ditches for the purpose of laying tile in them.

Generally drainage is of the greatest service in a marsh in the spring, since at that time the free water in the cultivated soil needs to be removed by deep drainage to allow the roots of crops to go deep into the subsoil and become well established.

Good Drainage Favors Deep Rooting. Sometimes during dry summers crops planted on poorly drained marshes actually suffer for want of water. This condition leads many to infer that drainage has been harmful. The real fact is that when crops are planted on poorly drained marshes the roots establish themselves in the surface area, which soon dries out during a dry period. Strangely enough, the lowering of the water table during a wet spring actually increases the amount of water available to the plants later in the season. This is due to the fact that the early drainage develops a deep root system.

Drainage Not Complete in Districts. In most drainage districts only the outlet ditches have been put in and these are paid for by the sale of bonds, which constitute a lien on the land and must be paid during the following 15 to 20 years. Complete drainage must be installed later by the owner. The man who is thinking of purchasing land in a drainage district, therefore, should determine the full cost of its complete drainage as well as its state of fertility and crop adaptation.*

CLEARING AND PREPARATION OF SEED BED

Clearing Helps Development. The native growth of trees on marsh lands must be removed. Ordinarily their shallow root systems make this clearing very simple. There are also considerable areas, especially in the northern portion of the state, on which there is a very deep growth of sphagnum moss. Other marshes support heavy growths of grass. It is usually difficult or impossible to plow such lands properly before this growth has been removed.

Burn Moss and Rank Grass. The easiest way to remove deep moss and thick grass growth is to burn it. Ordinarily it is not considered desirable to burn marshes more than is absolutely necessary, but in such cases it cannot be avoided. There is much less objection to burning on marsh lands than on uplands, provided only as much of the surface is burned as is necessary to permit of good breaking. Indeed, the ash from this shallow surface burning increases greatly the productivity of these lands for the first few years. Where the moss has conconsiderable depth and on boggy marshes, burning is possible only during a dry season. In the hot summer months great care must be taken to prevent the spread of the fire.

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*See Bulletin 284 for complete discussion of drainage.

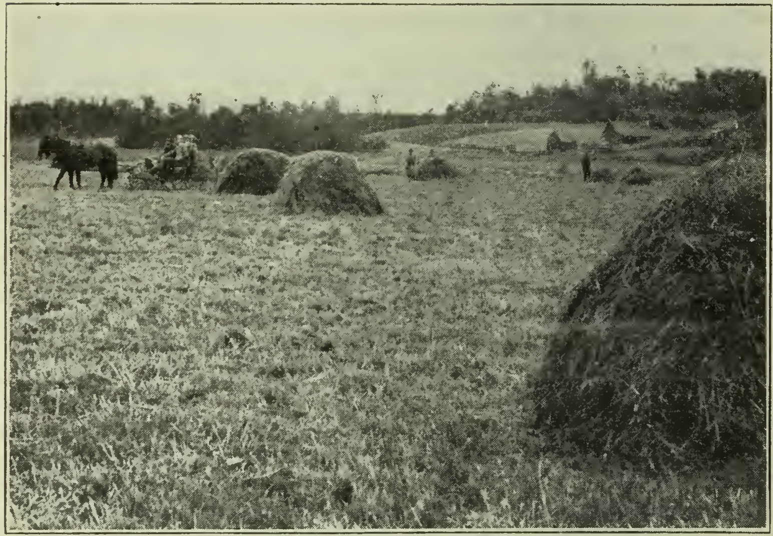

FIG. 1.—A PROFITABLE CROP ON A PEAT MARSH

Two tons of clover and timothy hay were harvested from an acre of raw peat marsh in Price county. The field had been seeded that spring.

Breaking Should Be Done Well. The summer and early fall are the best times for the plowing, whether burning is necessary or not. Where the soil is mucky a good stubble plow can generally be used with success. Where the soil is peaty, however, a good breaking plow with very long moldboard must be used, and the wider the plow the more successfully can the furrow-slice be turned. On such lands a tractor is usually better motor power than are horses. The weight of such a plow helps in compacting the soil so as to secure a firmer seed bed. This compacting of the peaty soil doubtless hastens its rotting, hastens the necessary chemical decomposition to establish fertility, and greatly improves its tilth. Often a disk plow does excellent work after the first breaking.

This, of course, must not be understood as meaning that marsh lands which are merely wet clay soils and contain considerable well-decomposed organic matter should be compacted in this way. When these soils are too compact and "tight," as is often the case, they should be plowed with a horse plow and left undisturbed after drainage and plowing (if plowed in the fall) so as to allow the action of the frost to produce the granulation necessary to good tilth.

A Good Seed Bed Desirable. During the following spring the peat or muck breaking should be harrowed three or four times with a cutaway or full disk harrow to secure a good seed bed. Nearly all grain should be planted with a drill about two or three inches deep, in order to secure a good supply of moisture. Small seeds such as clover and timothy, which cannot force their way through much soil, should be planted about one and one-half inches deep. The compacting of the surface soil even after seeding is very important in case of small seeds.

When the original sod has been completely decomposed through cultivation and cropping, peats and mucks usually become very loose. It should be remembered that looseness or mellowness is not the only condition indicating a favorable seed bed. Aside from having a certain degree of mellowness, a good seed bed should have a certain degree of firmness or compactness as well. Thus, when a peat or muck becomes too loose, it should be rolled, even before planting. Rolling after planting is also recommended.

If marsh soils are to continue in their present state of productivity, more thorough and better methods of cultivation must be practiced. A small tract of marsh land properly managed and tilled will give a larger net return for the amount of money expended than a larger acreage poorly cultivated.

FERTILIZER NEEDS OF MARSH SOILS

Marsh Soils of Three Types. In order that we may understand clearly the fertilizer needs of marsh lands it is necessary that we discriminate between the different soils included in the term "marsh soils," and that we know their physical and chemical characteristics. Three distinct types of marsh soils are recognized—peat, muck, and "marsh-border soils."

Peat. A peat is a soil high in organic matter, usually running from 75 to 95 per cent, but occasionally as low as 50 per cent. The difference between the per cent of organic matter and 100 per cent indicates the amount of silty or earthy material in the soil. The organic matter of peat may be in different stages of decomposition; that is, it may be quite fibrous and brown in color, or it may be well-decomposed and black in color.

Muck. Muck soils are those having smaller amounts of organic matter and correspondingly larger amounts of earthy matter. For purposes of classification, 15 per cent of total organic matter may be taken as the lower limit and 50 per cent as the higher limit in mucks, so that the percentage of silty or earthy matter varies from 50 to 85 per cent. The organic matter in mucks is usually much more fully decomposed than that of peat and seldom shows any vegetable tissue except that of recent growth.

"**Marsh-border Soils.**" The term "marsh-border soils" is used to apply to the soils which occur on the border of marshes where the change from marsh to upland conditions takes place, and which vary in organic matter from 5 to 15 per cent. The organic matter in these soils is usually black humus, shallow in depth, and the subsoil a blue or mottled clay or sand. With them should be grouped the shallow marsh soils low in organic matter occurring along streams or in depressions in upland.

All Marsh Soils Are Not Sour. It is commonly inferred that because lowlands are, or have been, wet or water-soaked, they are sour or acid. This is not necessarily true. Many very wet marsh soils have no trace whatever of acid. In limestone areas lowlands receiving the drainage from the surrounding upland containing lime are usually not acid, or are only slightly acid. This is the case in the marshes of the eastern and southern parts of the state. Marshes not in limestone sections, like those of the central and northern parts of the state, are very acid, and some marsh soils of the eastern and southern parts of the state are also acid.

Marsh Soils Differ in Weight and Chemical Composition. Each of the types of marsh soil have marked characteristics in regard to weight and chemical composition. Peat, when dry, weighs but 12 to 20 pounds to the cubic foot. Muck soil weighs from 40 to 50 pounds, while the "marsh-border" soils often run from 60 to 80 pounds to the cubic foot. The chemical composition also varies, especially in regard to nitrogen, which shows about the same variation that the organic matter does.

Marsh and Upland Soils Compared. Table I gives the average amount of the three most important elements found in clay, silt loam, sandy loam, and the three types of marsh soils, expressed in percentage, and as pounds to the acre to the depth of about eight inches.

TABLE I.—CHEMICAL COMPOSITION OF MARSH AND UPLAND SOILS

Soil	Percentage			Pounds per acre of 8 inches surface		
	Nitrogen	Phosphorus	Potassium	Nitrogen	Phosphorus	Potassium
Clay and silt loam..........	0.15	0.08	2.50	3,000	1,600	50,000
Sandy loam..................	0.10	0.04	1,00	2,500	1,000	20.000
Peat........................	3.00	0.15	0.20	10,500	525	700
Muck........................	1.00	0.10	0.75	10,000	1,090	7,500
"Marsh border"..........	0.50	0.05 to 0.10	1.00 to 2.00	10,000	1,000 to 2,000	20,000 to 40,000

It is to be noted that the nitrogen content (pounds) of all marsh soils is very high compared with upland soils. Peats are exceptionally rich in nitrogen because they are composed almost entirely of organic matter.

Peat soils, as a rule, are very low in the mineral elements, potassium and phosphorus. Mucks are better supplied with these two elements, though the potassium content is low in comparison with upland clay or silt loam.

The "marsh-border" soils are well supplied with both potassium and phosphorus as well as with nitrogen, and therefore have high cropping possibilities.

Potassium a Common Factor Limiting Crop Yields. Since peats and mucks are low in the element potassium, crops growing on those soils are limited in yield or fail entirely unless this element be supplied in the form of potash fertilizers and manure. It is a striking fact that the lighter peaty soils contain, on an average, only about 1/28 of the amount of potassium contained in a clay or silt loam. Mucky soils, having more earthy matter, have 1/12 to 1/6 as much. Some light peats, analyzing as low as 0.08 per cent potassium, contain only about 1/150 as much of this plant-food element as is contained in a good silt loam.

It is true, of course, that the large amount of potassium in the clay or earthy portion of the soil becomes available to plants only through a slow process of chemical decomposition. Nevertheless, when there is a good supply of organic matter in a clay loam soil, it does not ordinarily lack enough potassium to permit the growth of crops. The exceptions are heavy crops of those plants which take unusually large amounts of the element, crops such as cabbage, sugar beets, tobacco, or potatoes. In the case of peat soils the total amount of potassium actually present would often suffice for only a few crops, even if every particle of it were available, which is never the case, of course.

Potash Fertilizers. There are several kinds of potash fertilizers. Some of these are valuable for their potash only, while others also contain phosphorus and, often, nitrogen. Fertilizers containing two or all three of the elements, nitrogen, phosphorus, and potassium, are called mixed or commercial fertilizers. Those containing potash only, such as the muriate and sulphate of potash and kainite, have been almost entirely imported from Germany and the supply has been cut off by the war. On marsh soils needing only potash they are, of course, the cheapest and best fertilizers to use when they can be had. High grade muriate and sulphate of potash contain nearly 41 per cent of potassium and kainite contains from 10 to 12 per cent.

Mixed or commercial fertilizers ordinarily contain very small amounts of potassium, if any, but the fertilizer companies are beginning to manufacture mixed fertilizers which are especially adapted for marsh soils and contain from 8 to 10 per cent of potash, together with phosphorus and small amounts of nitrogen. On marsh soils needing both phosphorus and potassium such fertilizers are very satisfactory, though more expensive than an equivalent mixture of a high-grade potash fertilizer and acid phosphate. The percentage of potassium in the fertilizer must be considered in determining the amount to apply. There is as much potassium in 100 pounds of high-grade muriate of potash as in 1000 pounds of a mixed fertilizer containing but 5 per cent of potash.

Wood Ashes for Marsh Soils. Dry, unleached hardwood ashes ordinarily contain from 2 to 4 per cent of potassium. As the potash in wood ashes is very soluble it is important that they be protected from leaching. Ashes are sometimes allowed to accumulate near sawmills, especially in the northern part of the state, and can be had for the hauling. The effect of ashes on some of the marshes in the north central part of the state, which are decidedly acid, has been so beneficial that the results obtained could not be duplicated by any combination of commercial fertilizer. The alkalinity of these ashes evidently caused the peat to decay more rapidly, thus furnishing available nitrogen.

How Much Potash to Apply. The amount used depends largely upon the crops to be grown. Such rank-growing crops as beets and cabbage should have a heavier application than the cereals and hay grasses. When these crops are grown in rotation it may be unnecessary to use the potash fertilizer in seeding down with a cereal, following a crop on which a heavy application was used the previous year.

On marshes underlain by clay and where the overlying peat or muck is from 12 to 15 inches in depth, it frequently happens that there is a marked need of potash fertilizer or barnyard manure for a few years after it is first drained. After that time this need partly, or entirely, disappears. This is probably due to the fact that the settling of the peat or muck in draining and working permits the subsoil, which contains much larger quantities of potassium, to work up in the soil.

A marked illustration of this fact has occurred on the Experiment Station farm at Madison, where about 26 years ago a tract of land, then distinctly marsh, was tile-drained, and for the first few years showed a very great deficiency of available potassium. Fertilizers containing this element would increase the yield three- and sometimes four-fold. During the last few years, however, this marked need of potash fertilizers has largely disappeared. A part of the necessary potassium has become available from the subsoil while a need of phosphorus and nitrogen has gradually developed, so that a complete fertilizer, such as barnyard manure, is now the most helpful. It should be understood, however, that this condition can only develop on peat and muck soils that are comparatively shallow and underlain with clay.

It will be seen from Table I that the percentage of phosphorus in marsh soils is generally high compared with upland soils. Analyses of these soils, as far as made in this state, show a variation of from 0.053 to 0.26 per cent. When the extreme lightness of peat soils is considered, however, it is seen that the total amount of phosphorus occurring in them may be extremely small, in some cases not exceeding 185 pounds in the surface 8 inches of an acre of soil. Since good crops of grain or corn will remove annually from 8 to 12 pounds of phosphorus, it will be seen that the total amount at present may not be sufficient for more than 20 to 25 good crops. Moreover, a considerable part of the phosphorus present in the soil may not be available.

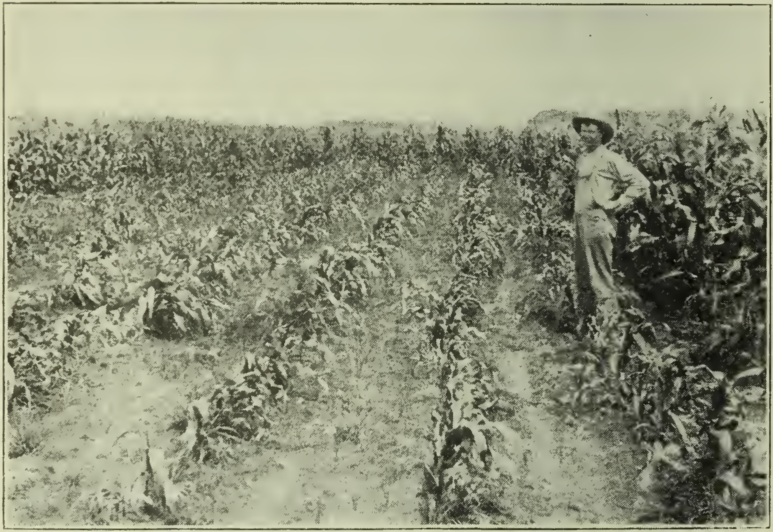

FIG. 2.—POTASH IS ALL THAT SOME MARSH SOILS NEED

Nine-foot corn was produced on this Waukesha county field after 150 pounds of muriate of potash had been applied to the acre. The untreated crop was too poor to harvest.

On the other hand, many marsh lands contain very much larger quantities of this element and in this respect compare favorably with upland soils. It is highly desirable, therefore, that before expensive reclamation is undertaken a chemical analysis be made of each area.

Phosphorus in Many Marshes Not Available. Experiments made on several different marshes in this state indicate that not only is there a great variation in the total amount of phosphorus present in marsh soils, but there is even greater difference in the readiness with which plants can extract that which is in the soil. Experiments made at Marinette with phosphate fertilizers on peaty marsh soils, underlain by sand, showed that phosphate, as well as potash fertilizers or manure, must be used before maximum crops can be grown on that marsh.

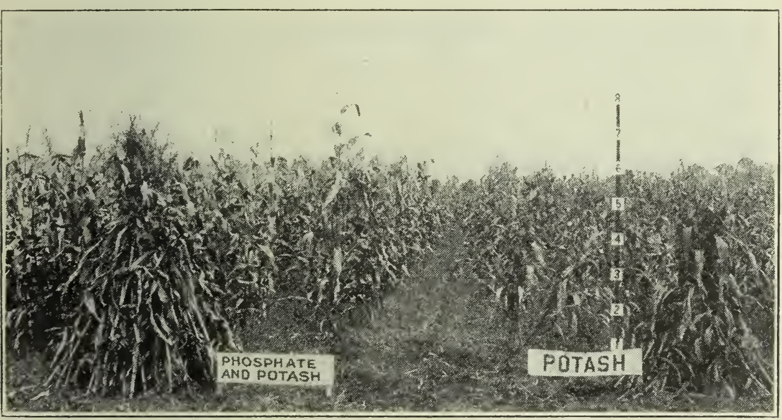

FIG. 3.—OTHER MARSH SOILS REQUIRE PHOSPHATES AS WELL AS POTASH

Muriate of potash costing about $4.50, used at the rate of 200 pounds to the acre produced 6.2 tons of green corn. A mixture of 200 pounds of potash and 400 pounds of acid phosphate costing $7.75 produced 14.5 tons to the acre. When no fertilizers were applied the yield of green corn was 2 tons to the acre.

On this peat soil without fertilizer practically no crop could be grown. With the use of one ton of wood ashes to furnish potash, a yield of 26 bushels of barley an acre was grown, and when 300 pounds of acid phosphate in addition to a ton of ashes were used to the acre, the yield of barley was 36 bushels an acre. When 300 pounds of acid phosphate were used in addition to the ashes a yield of 196 bushels of potatoes was obtained. With only the ashes the yield was 142 bushels and with no fertilizers the yield was 66 bushels an acre.

Acidity is one of the most important factors influencing the availability of phosphorus in marsh, as well as other, soils. As a general rule, it is found that acid soils are low in available phosphorus. The only exceptions to this rule are those cases where the soil is naturally acid but where the supply of available phosphorus is kept up by heavy applications of manure or other fertilizers. Since the marshes of the eastern and southern parts of the state are, for the most part, neutral or very slightly acid, the phosphorus in them is usually more available, while the very acid marshes of the central and northern parts, occurring in sandstone and granite regions, very commonly show marked deficiency in available phosphorus.

Some Marshes, Not Acid, Show Phosphorus Deficiency. Some marsh soils of the eastern and southern parts of the state, even though not acid, have shown a marked deficiency in the availability of their phosphorus content.

It is true, of course, that where the total phosphorus is low, no matter if the present supply is readily available, it will be exhausted in time and a deficiency will become apparent.

Phosphate Fertilizers. The best way to meet the deficiency of phosphorus in any soil is by applying phosphate fertilizers, of which there are four principal kinds, acid phosphate, ground steamed bonemeal, raw rock phosphate, and mixed fertilizers. Acid phosphate contains phosphorus in a soluble and available form, so that a smaller amount of it will give better results than in the other cases. It is the form which it is safest to use until a farmer knows definitely that his land requires a phosphorus fertilizer. It is probable, especially on marsh lands, that raw rock phosphate may prove cheaper in the long run, but it does not give such marked results the first year or two.

Use Both Potash and Phosphate Fertilizers. In many cases the use of just one kind of fertilizer does not give the best results on marsh soils. On many peats and mucks, particularly those of southern and southeastern Wisconsin, potash fertilizers alone give excellent results, especially during the first few years of cropping. But in many cases the addition of phosphates in greater or less amounts, depending on conditions, is necessary for the most profitable yields. On all acid marshes both kinds of fertilizers must be used. To facilitate application they should be mixed just before applying. Or mixed commercial fertilizers containing both potash and phosphorus may be used. These have some advantages over a homemade mixture of muriate of potash and acid phosphate in that a filler or drier is used which keeps the mixture in better mechanical condition for spreading. This makes the cost somewhat higher, of course.

HOW TO APPLY FERTILIZERS

Two methods of applying fertilizers are in use. They may be spread broadcast on the plowed ground and disked in before planting or seeding, or in the case of crops planted in drills or hills, they may be applied near the drill or hill by the use of planters carrying fertilizer attachments. When applied broadcast from 300 to 400 pounds of acid phosphate and 150 pounds of muriate of potash are the quantities best to use for all staple crops, such as hay, grain, or corn. For truck crops such as cabbage, sugar beets and onions, which make much heavier growth, these amounts should be increased from 50 to 100 per cent. When applied in the hill or drill the amount to the acre must be much less or there is danger of injury to the young seedlings. The use of 100 pounds of acid phosphate and 50 pounds of muriate of potash in this manner will often give nearly as much increase in yield during the first year as the larger application made broadcast, but yields on the land to which the larger application is made broadcast will be greater in succeeding years. When applying fertilizer in the hill or drill the planter used should be one which carries the fertilizer in a separate box from which a separate tube runs to the soil. In this way some soil is allowed to fall between the seed and fertilizer.

When Potash Fertilizers Are Not Available. When potash fertilizers, manure, and wood ashes are not available, very good results can be obtained by using a 0–10–10* mixed fertilizer applied in the hill or drill with a fertilizer attachment at the rate of from 150 pounds (when dropped in the hill) to 300 pounds (when dropped in drills) to the acre. In case of truck crops 300 to 400 pounds an acre of a mixed fertilizer are often applied, broadcast, in addition to 100 to 200 pounds applied in the drills.

COMMERCIAL FERTILIZERS MAY BE MORE ECONOMICAL THAN MANURE

On marsh soils where there is a deficiency of only phosphorus and potash and almost an over-supply of nitrogen, it does not seem wise to use manure, which contains considerable nitrogen and a much smaller amount of phosphorus and potassium. The amount of phosphorus and potassium in 10 tons of manure can be applied in the form of acid phosphate or bonemeal and muriate of potash (at normal prices) at a total cost of $4.50 to $5. The manure can be used to better advantage on high land which needs all the elements manure contains, particularly nitrogen. Nevertheless, it is often best to use fertilizers containing 1 or 2 per cent of nitrogen for crops planted early which must make a quick start to be successful.

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*A 0-10-10 mixed fertilizer means a fertilizer containing no nitrogen, 10 per cent phosphoric acid (phosphorus) and 10 per cent potash (potassium).

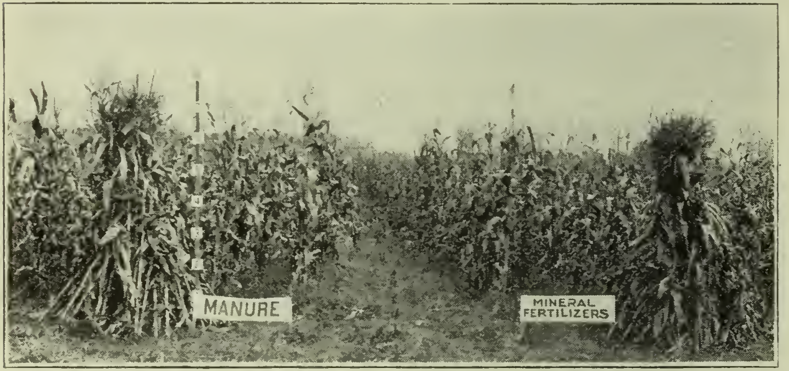

FIG. 4.—HOW MANURE AND MINERAL FERTILIZERS COMPARE ON MARSH SOILS

It is more profitable to apply manure to upland and buy mineral fertilizer to marsh soils. Manure worth $37.50 produced only 3.5 tons more silage to the acre than $9 worth of rock phosphate and muriate of potash. The test was made in Rock county.

Manure Adds Helpful Soil Organisms. While it may not be profitable to apply manure for the purpose of adding plant food, it seems advisable to use it on marsh soil occasionally for the purpose of adding the bacteria that hasten the decay of raw peat. The use of manure, particularly horse manure, has given an increase of crops that could not be explained by the addition of the small amount of plant food. It is probable that this was due to the work of bacteria that were added with the manure. It is advisable, therefore, to apply manure (especially horse manure) to marsh soils, but the application should be light, and should be put on with the idea of seeding as much of the soil with bacteria as possible. Five to six tons to the acre will be sufficient for this purpose. To secure the best crops the usual application of commercial fertilizer should be used with this manurial treatment. In many of the tests made on marsh soils it has been clearly demonstrated that phosphorus and potash fertilizers produce the best crops on soils which have been manured one, two, or three years previous to the time of making the application.

Mineral Fertilizers More Profitable. On a marsh at Palmyra (1913) an application of 15 tons of manure to the acre produced 10.5 tons of silage corn, and a heavy application of 400 pounds of muriate of potash applied broadcast produced 13.9 tons. The 15 tons of manure was valued at not less than $22.50 and the potash at $9. It is to be observed that $9 worth of potash fertilizer produced 3.4 tons more to the acre than $22.50 worth of manure. The manure in this case affected succeeding crops less than the potash, due, no doubt, to the exhaustion of the potassium.

On another marsh at Evansville (1913) an application of 25 tons of manure to the acre produced 15.8 tons of silage corn, and a mixture of 800 pounds of rock phosphate and 200 pounds of muriate of potash produced 12.3 tons. Here $37.50 worth of manure produced only 3.5 tons more corn than about $9 worth of mineral fertilizers. In other words, it took $28.50 worth more fertilizer in the form of manure to produce 3.5 tons more corn than was produced by $9 worth of phosphate and potash fertilizers. The results of this test, shown in figure 5, are sufficient to emphasize the fact that manure may be used to better advantage when applied to upland soils.

LIME ON MARSH SOILS

Whether lime should be used generally on acid marsh soils in Wisconsin is a question which has not yet been fully answered. The acidity of marsh soils is largely due to soluble acids which are, to a considerable extent, washed out after the land has been thoroughly drained. In this respect the acidity of marsh soils differs from the acidity of upland soils, which is not removed but rather increased by water soaking down through the soil. It is necessary to neutralize partly the acidity of soils to make them better fitted for the legumes, such as clovers and soybeans, which need more lime than most other plants. If these crops are grown on acid marsh lands it will doubtless be desirable to use lime.

Another benefit due to liming is the furthering of the chemical reactions in the soil by which the nitrogen becomes soluble and available to crops. In the case of cold raw marshes and especially in the northern part of the state, lime will undoubtedly hasten the growth of crops early in the season. In some cases liming has been found beneficial, while in others it has not proved profitable. Further experiments and studies are necessary.

When lime is used on marsh soils it should be worked in to a depth of several inches. Spreading any form of lime on the surface and then disking it in thoroughly while getting the land ready for planting is the best method of applying it. Two tons of ground limestone or air-slaked lime to an acre is a fair application.

Soils may be tested for acidity by using blue litmus paper. Get 5 cents worth of blue litmus paper from the local druggist and go into the field soon after a rain, while the surface soil is still quite moist. With a clean jack knife cut a slit into the soil and in this slit insert a sheet of the blue litmus paper, pressing the soil firmly around it. After five minutes examine the paper carefully, and if any red spots appear on the blue surface it can safely be said that the soil is acid. Care should be taken in handling the litmus paper that the portion used for the test does not come in contact with the perspiring hand, for perspiration has the same effect on the color of the paper that an acid soil has.

CROPS ON MARSH SOILS

Well-drained marsh-border soils, mucks, and well-drained and fairly well-decomposed peats are adapted to a large variety of crops. When crops are selected for any particular marsh area, however, consideration should be given the danger of injury from frosts.

Frost Often Injures Crops on Marshes. Crops on marshes are more subject to injury from frost than those on upland soils. Frosts often occur on marshes when they do not occur on surrounding higher land. The cold air settles to the ground on higher land and flows down to the lower land so that frost occurs there even though it does not occur on the high land. Marsh soils, on account of their loose character and large amount of vegetable matter, do not permit the heat from the sun's rays to penetrate the soil as it does on sandy or more earthy soils. The heat is caught at the very surface of the soil and is radiated back into the air, so that when night comes on and the soil continues to lose heat by radiation, lower temperature is reached than in the case of the more earthy soils. Heavy rolling, which compacts the soil, makes easier the entrance of heat and lessens the danger from frost.

Frost is as likely to occur on marsh land at any given point as it is on upland earthy soils 150 miles farther north. As a result, corn is not a sure crop on marshes in the central part of the state, though it can usually be grown to a silage stage. In the northern part of the state no effort should be made to grow corn on marsh land. Crops such as buckwheat and potatoes cannot be considered safe on marsh land in the central and northern parts of the state.

Crops Best to Grow on New Marsh Land. When marsh land is first placed under cultivation the number of crops that can be grown successfully is limited, especially if the soil is tough peat. Soybeans, buckwheat, flax, timothy and alsike clover are, commonly, the best first crops. On mucks and well-decomposed peats of southern Wisconsin corn is very frequently planted as the first crop. Rye will also do well and is frequently used as a nurse crop for grass and clover seeding.

Buckwheat. Buckwheat is usually grown because it has a shallow root system and makes fair growth with shallow drainage. It requires only a short growing season. Buckwheat does not lodge so readily as do grain crops. The principal objection to growing buckwheat is that when seeded too early the flowers are likely to blight, and when seeded too late the plant is subject to frost. The usual planting time is in June, preferably the middle of June, and the seeding at the rate of one-half bushel of Silver Hull or three pecks of Japanese buckwheat seed to the acre.

Soybeans. Soybeans are usually grown on light soils, but recent tests indicate that they grow successfully on well-drained, raw, peat marshes, producing a large yield. They should be grown principally to furnish a feed higher in protein than the average hay crop produced on marsh land, and should be used also in combination with corn for silage purposes.

Early varieties of soybeans, such as the Wisconsin Black and Medium Early Green, can be grown for seed purposes and sold as a cash crop. Ito San or Black Eyebrow soybeans or any of the early varieties may also be used for hay. To grow them successfully the field should be prepared the same as for growing corn. Thorough inoculation is just as necessary on marsh as on sandy soils. They should be planted in rows two to three feet apart, and cultivated. The rate of seeding should be about 25 to 30 pounds to the acre.

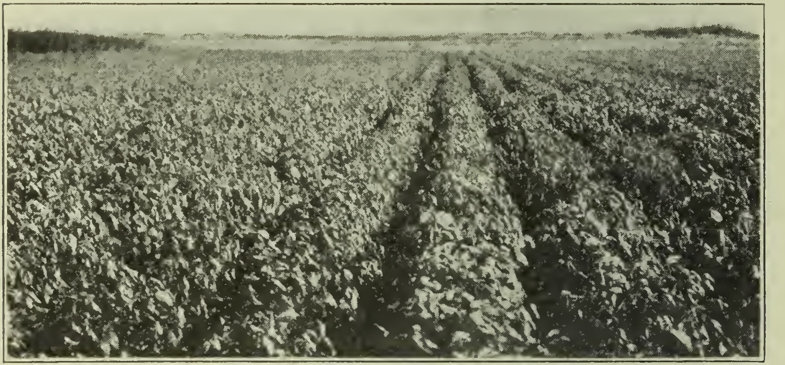

FIG. 5.—SOYBEANS ADAPTED TO PEAT MARSH LANDS

The soybean is one of the best high-protein crops for the marsh farmer.

Flax. Flax has been grown quite successfully on marshes in central Wisconsin. Although it is recommended as a good first crop on tough peat, yet it cannot be strongly recommended as a permanent crop for marsh soils because of its small root system and its inability to secure sufficient plant-food elements. Flax grows best on land well supplied with humus and available nitrogen.

Flax should be planted sometime during the latter part of May or, preferably, in June. Fall-plowed land is better than spring-plowed. A good seed bed is desirable. When the crop is grown for seed 3 or 4 pecks of seed should be planted to the acre; when grown for fiber, 2 to 2½ bushels to the acre. Thick seeding will prevent branching of the plant, thus producing a long straight straw. When planted with a seeder the grain should be covered with a light harrow and then rolled thoroughly.

Timothy and Alsike Clover. Timothy and alsike clover are grown extensively on marsh soils in central and northern Wisconsin, usually being one of the first crops planted. Excellent yields of hay have been obtained on well-drained marshes. Proper fertilization increases the yield. On peat soil near Bancroft the yield of hay in 1917 was increased from 1¼ tons to 3 tons an acre by the use of phosphate and potash fertilizers applied in 1916.

Timothy and alsike clover grow best when seeded early in spring, although timothy alone will grow best when seeded in September or early fall. The land should be prepared in the same way as for other crops. A nurse crop of oats or fall-sown rye can be used if it is not sown too thickly. Timothy is often seeded in the fall with rye, and alsike clover is seeded the following spring. Thorough compacting of peat soils is essential in growing successful crops of timothy and alsike. On some peat soils, where the surface has been burned over, timothy and alsike clover have been seeded in the ashes and dragged in. Although some good crops have been secured in this way, the practice cannot be generally recommended.

Timothy and alsike clover are shallow-rooted crops and are grown frequently on poorly drained marshes. The quality of hay secured where poor drainage exists is not good, being quite low in feeding value. Timothy when grown alone is frequently cut when too mature, which results in poor hay. These two factors combined with the lack of available nitrogen in raw peat soils and the consequent low protein content of the hay, have given tame hay grown on marshes a poor reputation on some markets in central Wisconsin. When properly grown and handled, timothy and alsike clover hay, grown on well-drained peat, is of as good quality as that grown on upland.

Other Grasses. Bluegrass, redtop, meadow fescue, and orchard grass are often recommended and grown successfully on peat soils. They may be used on poorly drained marshes, but on the better drained areas clover and alfalfa are superior in both yield and feeding value.

Corn. New, raw peat lands are not adapted to corn growing, nor can the later varieties be grown on well-decomposed peat or muck soils without more or less injury by frosts in the early fall. Wisconsin No. 8 and Wisconsin No. 25 are varieties of purebred corn which have matured during some seasons on central and northern Wisconsin marshes. Wisconsin No. 12, a purebred yellow dent variety, is best adapted for silage purposes, as it has a fair-sized stalk and a medium to large ear, and matures fairly well during the average growing season. It makes better silage than some of the later varieties which produce a large stalk and comparatively small ears during the short growing season. Corn and soybeans can be grown together for silage purposes, thus increasing the value of the feed. A light application of manure combined with a liberal dressing of phosphorus and potash fertilizers should be used to grow the best possible crop of corn on peat soils.

Red Clover. It is commonly supposed that neither medium nor mammoth clover will grow on peat soils. While they are not so hardy as alsike clover, yet they will grow on drained peat lands. Mammoth clover appears to be more hardy than medium red clover. To grow these clovers successfully the field should be limed if acid, fertilized, inoculated, thoroughly cultivated, compacted, and seeded with a light nurse crop.

The advantage of growing red clover rather than alsike and timothy is in its superiority as a feed for dairy cows and the fact that it adds more available nitrogen to the soil. Some truck farmers on muck soils in southern Wisconsin grow medium red clover once every four or five years, primarily for a green manuring crop to furnish readily available nitrogen and humus for such crops as onions or sugar beets.

Potatoes. Potatoes have been grown successfully on marshes in central Wisconsin where the drainage is good and where the field has been cropped two or three years. New peat land does not grow a large crop of potatoes. Wet lands produce soggy potatoes not valued for cooking. The soil should be prepared well and fertilized for growing potatoes. An application of 200 pounds of muriate of potash and 200 pounds of acid phosphate has produced good results. From 500 to 1000 pounds an acre of a 0-10-10 fertilizer would also increase yields of potatoes.

Due to early autumn frosts late varieties of potatoes have not yielded so well as the early varieties. The Triumph and Early Ohio are better than the Early Rose, while of the late varieties the Rural New Yorker is better adapted than the Green Mountain. To avoid the early fall frosts all potatoes should be planted as soon as seasonal conditions will permit. Too early planting, however, where the soil is cold and wet, will cause rotting of the seed tubers and a poor stand. The yield of potatoes on the average marsh in central Wisconsin varies from 75 to 150 bushels an acre.

Truck Crops. Cabbage, sugar beets, onions, and celery are grown successfully on thoroughly drained mucks and on well-drained and well-decomposed peats of southeastern Wisconsin. Since the soils in this section are usually well supplied with lime, success with truck crops may be largely attributed to this fact.

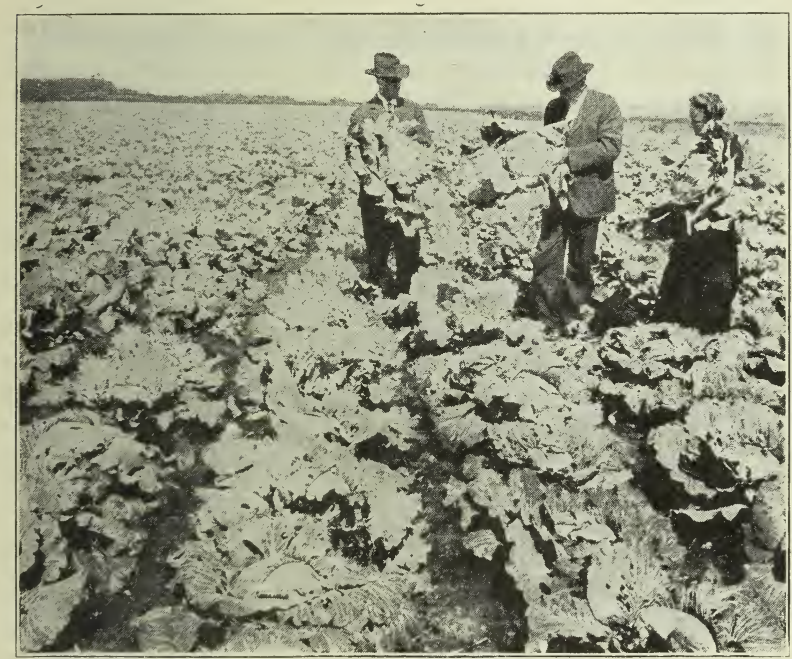

FIG. 6.—MARSH SOILS GROW TRUCK CROPS

Unusually heavy crops of cabbage have been grown on marsh land in Dane county.

Alfalfa on Marsh Soils. Because of their lack of drainage, marsh soils are generally not well adapted to alfalfa. In the eastern and southeastern sections of the state where the marsh tracts are, as a rule, parts of upland farms, the alfalfa should be raised on the upland and the marshes should be used for raising crops other than legumes.

In other sections where marshes cover large areas and farms consist entirely of this class of soils farmers may still desire to raise some alfalfa. Experiments on this class of soil tend to indicate that alfalfa can be grown on well-drained marshes where the free water in the soil never gets higher than two feet from the surface. If for any reason the water does rise to the surface or cover it at any time of the year alfalfa should never be attempted.

To insure best results under favorable drainage conditions fall plowing and thorough cultivation are necessary. The alfalfa should be planted on a field which has been cultivated and kept free from weeds during the previous season. During the early spring months, or as early as possible, and at intervals of two weeks, the field should be harrowed to kill weeds and make plant-food materials available. Before the seeding, 75 pounds of muriate of potash and 300 pounds of steamed bonemeal to the acre should be applied to furnish available mineral elements—potassium and phosphorus—and some nitrogen. On acid marsh soils lime in some form is also necessary.

Inoculation, too, should not be forgotten. This may be done in either of two ways: soil obtained from a field where alfalfa has been grown successfully may be applied at the rate of about a wagon box full for three or four acres; or artificial alfalfa cultures may be used. Inoculation may seem unnecessary, yet it should be done to introduce into the soil the proper organisms for the production of nodules on the roots of the alfalfa. Alfalfa should be planted during the month of May or the first part of June, the exact time of planting depending on the local weather conditions; that is, when sufficient moisture is present in the surface soil to germinate the seed readily.

The experimental work done up to the present time indicates that Grimm alfalfa is more hardy and will not winterkill so easily as the common alfalfa and should be used on marsh soils. Grimm alfalfa also grows more rapidly after each cutting on these soils.

Hemp. Hemp is grown somewhat extensively and with good success on the silt loam soils of eastern and southeastern Wisconsin. At present only a small percentage is grown in marsh soils. Experimental work indicates that where phosphate and potash fertilizers are used good yields of hemp can be grown on the marsh soils of central Wisconsin, but the quality of the fiber is not so good as that produced on high land. The plant needs a large amount of available nitrogen as well as other mineral elements to make a quick rank growth.

In order to grow hemp special knowledge as to methods of growing and handling the crop and special machinery are necessary. From 400 to 500 acres should be grown in a locality to make it a profitable venture. The best methods of growing and retting hemp must also be carefully studied. The fiber from hemp is used to make binder twine, ropes, and sacks. Owing to the scarcity of raw material, hemp fiber has been high-priced in recent years, and the growing of hemp should be profitable for those who are willing to make a special effort to grow the crop.

MARSHES OF DIFFERENT SECTIONS AND THEIR CROP ADAPTATION

Owing to great differences in the underlying rocks of different parts of the state and the nature of the subsoil, very important differences are found in the marsh soils of different sections of the state. The central and northern marshes are generally highly acid and require both phosphate and potash fertilizers. The eastern and southeastern marshes are generally not acid, and differ from each other in their fertilizer requirements. Since marsh soils as a whole are likely to be cold and affected by local frosts, the differences in climate between the southern and northern parts of the state are important in determining the crops which can be grown. It is desirable to consider separately the character and uses of marsh lands in each of the different sections of the state.

Marshes of Southeastern Wisconsin

Eastern and southeastern Wisconsin, bounded on the northwest by a nearly straight line from Green Bay to Madison and then southwest through Monroe, includes an area the underlying rocks of which are largely limestone. In passing over the larger part of that region during the glacial period the ice ground up large quantities of this limestone and mixed it with the surface soil in such a way as to produce a clay subsoil highly charged with carbonate of lime. The marshes and shallow lakes left after the melting of the glacial ice are gradually filling up, partly with the remains of vegetation growing on them and partly with sediment washed in from the surrounding higher ground. In this way the carbonate of lime is dissolved and carried into the marsh lands by the surface water and underground seepage, so as to largely neutralize the natural tendency of the marsh soils to become acid. As a rule, therefore, the marsh soils in the southern and southeastern parts of the state are not acid, or only slightly acid.

Quite frequently these marshes, when planted to corn or other crops, show patches of from a few rods to several acres in extent on which the seed germinates well, but the crop turns yellow at an early stage and fails to develop. It frequently happens that corn will grow to a height of only one or two feet during the whole season and produce no grain whatever. Where this occurs it is due either to the lack of sufficient drainage or to the lack of a supply of available potassium or of potassium and phosphorus.

In many cases experiments made during the last 10 years on soils of different characters in this portion of the state, have shown increases in yield all the way from two to five or six times, by the application of potash fertilizers only. Where manure is available a good application of especially strawy horse manure will be as effective as the potash fertilizer. Ordinarily there is a use for all barnyard manure on uplands, and, in that case, it is good economy to use only the necessary element on the marsh lands. The burning over of the surface moss or peat to a shallow depth will, of course, leave in the ash a supply of available potash which will be sufficient for crops from one to three years. This practice is not detrimental under certain conditions. (Page 5.)

Best Crops for Southeastern Marshes. On account of the large supply of nitrogen in these soils they are especially well adapted to crops which produce a rank growth and require large amounts of this element, such as corn, cabbage, beets, and potatoes. Of course, the quality of potatoes and sugar beets may not be quite so good as if grown on upland soil. Owing to the large supplies of nitrogen, small grains generally do not do well, though during comparatively dry seasons heavy yields of grains can be grown if a sufficient supply of mineral elements is present. Probably the best use of these lands on general farms, and dairy farms especially, is for the growing of hay and corn. A mixture of timothy and alsike clover grows extremely well and produces hay of good quality.

MARSH SOILS OF THE SANDY SECTIONS

Large areas of marsh soil having sandy subsoils and surrounded by sandy uplands occur in the central, northeastern, and northwestern portions of the state. The soil of these marshes is either a light muck or a distinct peat. They are always acid because there is practically no lime in the subsoil or surrounding country to be carried into the marsh by water. Such soils always require fertilizers containing phosphorus and potash unless they have been recently burned over. When the farm contains upland soil to which manure can be applied it should be used there and commercial fertilizers containing only the necessary elements should be purchased for the marsh land. In most cases these soils will probably be benefited by the lime.

Crops Best for Marshes in Sandy Sections. In considering crops account must be taken of the liability to frost. This makes corn and potatoes uncertain. The best staple crop is hay, chiefly timothy and alsike clover. Hardy special crops can also be grown when properly managed. Proper preparation of the soil, especially the use of a heavy roller, and drainage must not be overlooked.

MARSH LANDS OF NORTHERN SECTIONS

In almost all of the central portion of the northern part of the state clay soils abound. Scattered over this entire region are marshes of various sizes, nearly all of them underlain by clay subsoil. Very little has been done in their development as yet, and undoubtedly much is still to be learned regarding their possibilities and treatment. Certain differences, however, must be recognized between these marshes and those of the other areas. In the first place, these marshes are frequently of comparatively small size and surrounded by higher land still covered with a growth of native trees sufficient to greatly retard air drainage. This, together with the clay subsoil, poor water drainage, and their northern location, makes them very much colder and more subject to summer frosts than are the marshes of the other sections. They are not so rapidly drained as those with a sandy subsoil, but probably have more silt and earthy matter in them. The underlying rocks of this region are largely granites and other crystalline rocks not containing lime carbonate, and the marsh soils are, therefore, extremely acid. On account of their coldness and this acidity, even the large amount of nitrogen in the vegetable matter does not, at least in some cases, nitrify rapidly enough to supply growing crops.

On one experiment field at Phillips the use of hardwood ashes was found to be extremely beneficial, much more so than the use of corresponding amounts of phosphate and potash fertilizers. This, together with the fact that much improvement has been made by the use of lime in addition to phosphate and potash fertilizers, indicates that their coldness and sourness is such as to make the rate of nitrification too slow for good crops. Under similar conditions it is quite probable that the use of either water-slaked fresh lime or ground limestone will be found very helpful. The use of barnyard manure, especially strawy horse manure, is also very helpful in increasing the nitrification under such conditions, as well as in supplying some more readily available nitrogen, phosphorus, and potassium. When such lands are first cleared, a dressing of horse manure is very beneficial.

Crops for Northern Marshes. On account of the coldness of these soils, corn and potatoes are now out of the question. Probably the best use that can be made of them is for the growing of hay, for which a mixture of timothy and alsike clover is perhaps preferred. Since these marsh lands, where they can be readily drained, are more easily cleared than upland soils, their use for the growing of hay for winter feed is of the greatest aid in the development of agriculture.

Small grains can be grown to a limited extent on such soils where proper care is taken. Cabbage, rape, and turnips also may be grown.

ROTATION OF CROPS ON MARSH SOIL

Benefits of Rotation. Rotation aids greatly in avoiding diseases and insects which develop in soils kept continuously in the same crop. It also permits the addition of the more easily decomposed organic matter, such as manure, sod, and green crops. Hence, rotation is often desirable on marsh soils to increase productiveness.

Clover Benefits Marsh Soils. It seems unnecessary to add organic matter to peat which in itself is practically all organic matter, yet it is recognized as a good practice, especially when potatoes, cabbage, sugar beets, and onions are raised. Using proper fertilizers, combined with a crop rotation containing clover, or clover and timothy, is safe and wise. On farms consisting entirely of marsh it is as important to grow alfalfa and clover as it is on upland soils.

With the placing of a legume or hay crop in the rotation some small grain such as rye or oats must necessarily be grown, but they are considered less desirable crops for this kind of soil because of the tendency to lodge. If corn or some other cultivated crop is raised the first three years and the soil is treated with the proper mineral fertilizers during that time grain may be grown very successfully, provided less seed be sown than on upland soil. If the grain crop is too rank even then it would be well to cut it for hay in order to save the seeding.

Practical Rotations. If a farmer has 30 acres of peat and desires to grow cabbage and sugar beets as cash crops, it is a good plan to divide the field into four strips and crop them to sugar beets, cabbage, grain, and hay, respectively, in the order named. Thus, a four-year rotation of hay, sugar beets, cabbage and grain would be practiced on each strip. On a dairy farm, two or three corn crops may be grown in succession, followed by grain, and then seeded to alsike clover and timothy. The hay may be cut the first year and pastured the second. The rotation best suited to any peat marsh can best be determined by the conditions existing on that particular farm.

MARSH SOILS IN RELATION TO TYPES OF FARMING

Marsh Adapted to Three Types of Farming. Marsh soils are adaped to three types of farming, stock raising or dairy farming, truck farming, or a combination of the two in which neither type predominates. Grain farming cannot as yet be recommended on marsh soils. In many localities a one-crop system is being followed where celery, peppermint, or some other crop is the entire source of income. While a rotation of crops is not absolutely necessary a change of crops is desirable to aid in controlling insect pests and diseases. Farmers who specialize in a one-crop system do not pay much attention to minor crops unless the principal crop is threatened by disease.

Grain Farming Not Adapted to Marsh Lands. Grain farming, in which grains are sold and form the entire source of income, cannot be recommended on either peat or muck soils in Wisconsin. The unbalanced condition of the plant-food elements in the soil makes them unadaptable for grains. Marsh soils are high in nitrogen, which produces a rank growth of straw, but they do not contain enough potassium to stiffen the straw and make it stand up, nor enough phosphorus to produce grain and fill the head properly. This means lodging, with the consequent poor crop and chaffy grain. Grain crops grown on peat soils are also subject to blight and rust, which cut down the general yield. While it is possible to grow good grain on peat soils properly fertilized with phosphates and potash, it is practicable only when grain is desirable in a rotation.

Dairying Possible on an All-Marsh Farm. On most of the peat soils in central Wisconsin dairy farming or stock raising will prove very profitable. This is particularly true on the newly drained marshes where the peat soil is quite raw. These raw peats, with a little care and effort, will make good pasture lands, but they would not grow truck crops until more decomposed. The droppings of the cattle start bacterial action, which, together with the firming of the soil by tramping of stock, hastens the decomposition of the peat and helps fit it for other crops. Farmers in central Wisconsin who are pasturing stock during the summer find that after two or three years, the texture of peat soils is entirely changed. Legume crops such as soybeans, alfalfa, and red clover, all high in protein, have not been grown very extensively on central Wisconsin marshes, but they flourish on well-drained areas. When these crops take the place of wild marsh grasses, timothy and bluegrass, more livestock can be fed profitably. Corn for seed cannot usually be grown in the northern part of the state because of the early frosts, but good corn can usually be grown for the silo and when combined with soybeans it makes excellent silage. With soybean-corn silage and alfalfa hay to feed, very little concentrated feeding stuffs will have to be purchased.

Many Marshes Well Adapted to Trucking. Many pieces of marsh land are admirably adapted to truck farming or the growing of certain special crops. This is particularly true of muck soils. Raw peat lands do not furnish sufficient available plant-food elements to grow these intensive crops, but when the peats become fairly well-decomposed or are fertilized heavily they will produce truck crops. However, it is not advisable to recommend the growing of these crops extensively on marsh soils in Wisconsin, unless the grower is thoroughly familiar with all phases of growing truck crops.

Much Trucking on Marshes Not Necessary. In eight of the north central states—Ohio, Indiana, Michigan, Illinois, Wisconsin, Minnesota, Iowa, and Missouri—there are 15,000,000 acres of swamp land, which consist largely of muck soils capable of being drained and utilized for agricultural purposes. In the entire United States in 1909 there were 125,000 acres of cabbage, 50,000 acres of celery, and 8,000 acres of peppermint and spearmint, making a total of 198,000 acres, a* large percentage of which is on other than muck soil. That the production of these crops is sufficient is evidenced by the frequent over-production of one or more of them. It seems quite possi-

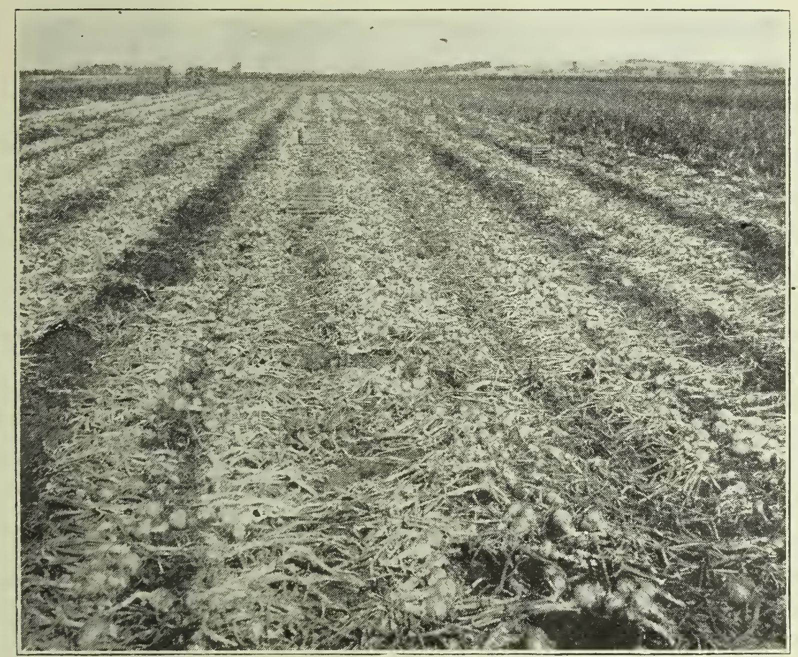

FIG. 7.—FERTILIZERS AID THE ONION CROP

Heavy applications of the right fertilizers must be used for truck crops to obtain such yields as this.

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*Farmers' Bulletin No. 761, of the United States Department of Agriculture.

ble that all of the celery, onions, mint, and cabbage needed by the whole United States could be grown on 1 or 2 per cent of the marsh land in these eight states.

The grower of intensive crops must also contend with an element of risk as well as uncertain returns. A study of truck markets shows a wide variation in price resulting in a fluctuation in the profit from an acre.

Truck farming also means the employment of a large amount of labor skilled in certain lines of work. This labor is necessarily expensive because of the limited time it is used. Where family labor is used to assist in the field the profits will be much larger.

The location of land and market facilities are important factors in truck raising. The largest truck farms are near large towns or good shipping points with facilities for immediate shipment to good markets. If the cost of hauling to town or shipping to market is very large, it reduces the profits or consumes them entirely. Such crops as lettuce, radishes, or bunch onions must be placed on the market fresh and crisp.

Some Causes of Failure. The truck farmer must also have special knowledge as to the best, cheapest, and most up-to-date method of growing each crop on the particular soil on which he is working. Farmers from Illinois, Indiana, Michigan, and other states have come to central Wisconsin to grow truck crops and found after one or two years' experience that lack of proper drainage, rawness of the peat soil, soil acidity, or a lack of mineral elements, have made the crops failures. The farmer must also be familiar with the best way of combating insect pests and fungous diseases, which are serious in some localities.

Best to Combine Dairying and Trucking. Nearly every farmer has some livestock, and many livestock farmers grow truck crops as a side line. This combination of dairy, truck, and grain farming should be followed extensively on Wisconsin muck and peat farms. The amount of grain grown should be limited to what is actually used on the farm. The profit should come through the stock and special crops which may be sold. This system of farming has two advantages,—it does not require so much capital as strictly dairy farming, and it gives a more steady income because of the variety of crops grown.

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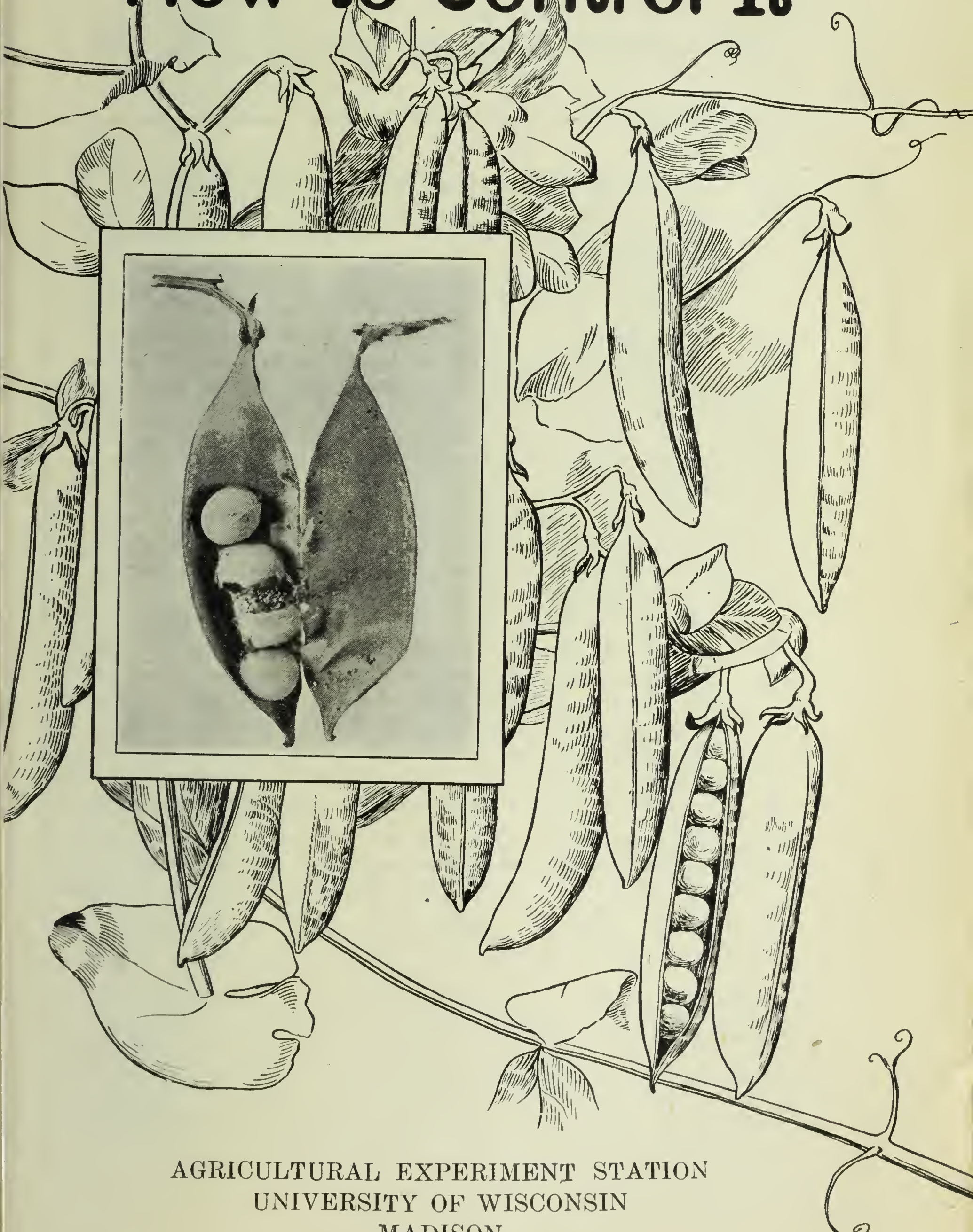
The Pea Moth
How to Control It



AGRICULTURAL EXPERIMENT STATION
UNIVERSITY OF WISCONSIN
MADISON

PEST MENACES IMPORTANT INDUSTRY

In the northeastern counties of Wisconsin pea growers are being troubled by the presence and activity of the pea moth, an insect which feeds within the pod on the growing peas. Investigators tell us that, so far as is known, this insect feeds only on peas, but it attacks both garden and field varieties.

We are told that during ten months of the year the moths are inactive, living in cocoons made a short distance below the surface of the soil; the other two months the insects are active, feeding and growing. Their eggs are laid on or near the pea vines and do not begin to hatch until after the middle of July.

Officials of our Agricultural Experiment Station advise as the best means of controlling the pest the selection of the earliest maturing varieties and the planting of the crop as early as possible in the spring.

In view of the fact that Wisconsin is the most important pea-packing state in the Union, it is highly necessary that everything possible be done to limit the damage and spread of this insect. The officials of our Experiment Station promise to give the matter continued study and to report their findings regularly to the pea growers of the state.

J. A. HAGEMANN, *Secretary,*
Wisconsin Pea Packers' Association.

The Pea Moth: How to Control It

C. L. Fluke, Jr.

The pea moth,* an insect which in the worm stage feeds within the pod on ripening peas, threatens the pea industry of Wisconsin. To check the damage and spread of this pest, select quickly maturing varieties and plant them as early in the spring as possible.

In pea-growing sections where actual counts have been made as many as half the pods have been found to be damaged. This increased destructiveness of the pea moth is largely responsible for the decline of the price paid to farmers for dried peas. Many dealers complain of the excessive number of injured peas in the bin and buyers are refusing to purchase such stock for soups.

At present the pea moth is found only in the northeastern counties of Wisconsin. It has been reported from Michigan but is not known to occur in any other state. It has been one of the principal pests of peas in Canada since 1893, having been introduced from Europe about that time. When it first came into Wisconsin, no one knows, but most of the Door County farmers seem to agree that they first saw the insect about 14 years ago.

The accompanying map shows the actual distribution of the pea moth in Wisconsin as found during the season of 1919. The light shading marks the area in which reports of damage to the pea crop seem to indicate the presence of the pea moth. The dark shading marks the area in which the pea moth was actually found and the percentage of infected pods, ranging from 2 per cent to 21 per cent, that was counted in the fields. In 1918 the infestation was much heavier, counts showing that 10 to 50 out of every 100 pods examined were attacked by the worms.

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* *Laspeyresia nigricana* Steph.——"The specimen of pea moth referred to us with slip of November 28 is a male and I have made comparison of the genitalia with that of the European pea moth, *Laspeyresia nigricana* Steph. The two are not at all alike. If this specimen is a genuine pea moth and if the specimens originally referred to England and identified then as *Laspeyresia nigricana* are the same, their determination was incorrect. It is possible, of course, that we may have both a native and the European species infesting peas in this country."

Carl Heinrich, United States National Museum.

In Door county the greatest damage was found near Sturgeon Bay, becoming lighter both north and south of the town. The least infestation was found in Oconto County. Peas from Ashland and Bayfield Counties were examined and found free from damage.

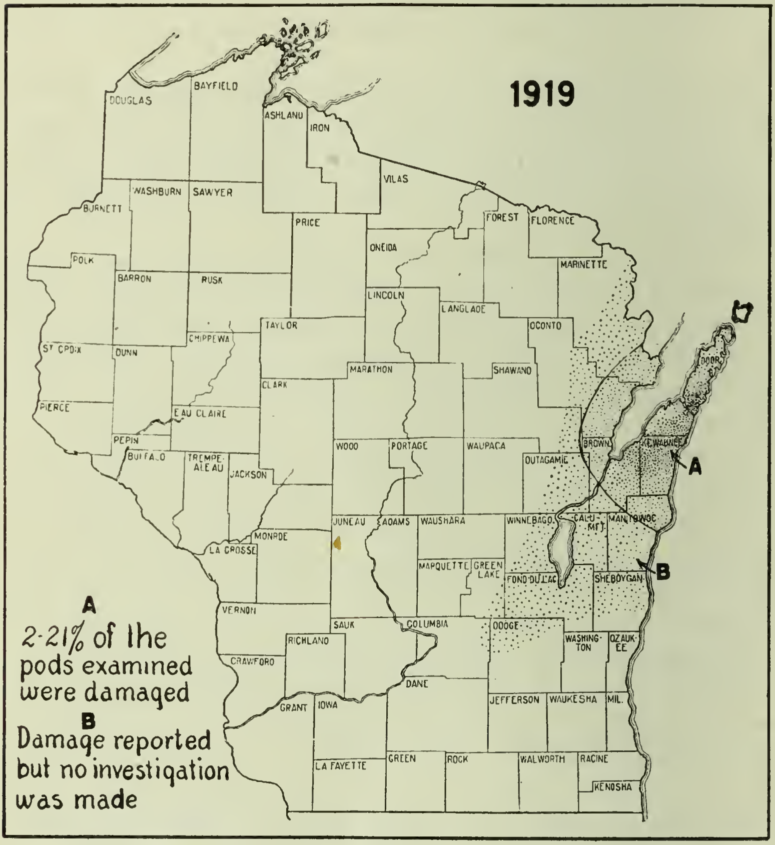

FIG. 1. DISTRIBUTION OF THE PEA MOTH IN WISCONSIN

Only the northeastern part of the state is infested with the pea moth, but the pest may spread into other pea growing sections unless it is checked.

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* The writer is greatly indebted to L. G. Gentner of the Bureau of Entomology, United States Department of Agriculture, for spending two weeks in June, 1919, in beginning the work and for taking pictures of material sent to him during the summer.

IT FEEDS ONLY ON PEAS

This moth is known to attack practically all varieties of both garden and field peas. No other host other than peas is known. It is quite possible that in the absence of this plant, their natural food, the worms might feed on other closely related plants.

Late varieties of peas are more susceptible to attack than the earlier maturing forms. This is due entirely to the time of appearance of the moth itself and not due to any varietal resistance of the peas.

HOW THE INSECT LOOKS IN DIFFERENT STAGES

Eggs. The eggs are small, not quite as large as the head of an ordinary pin, flat and slightly oval in shape, whitish in color, and nearly transparent when first laid. Within two days two reddish transverse streaks appear, one at each end of the developing embryo. They can be plainly seen with the naked eye. After 5 to 7 days, depending upon weather conditions, the dark head and black thoracic shield are formed and the worms within the eggs are then nearly ready to hatch.

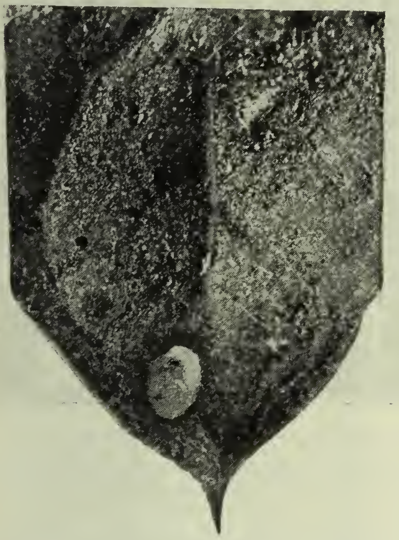

FIG. 2. THE EGGS ARE LAID ON LEAVES, STEMS, AND PODS

The eggs of the pea moth are quite small, but they may easily be seen with the naked eye. In the photograph the egg is enlarged 150 times.

Larvae. When first hatched, the larvae are pale, with the head and thoracic shield almost black. The full-grown worms are about ½ inch long, yellowish white in color, and with the spots on the sides of the body rather inconspicuous. The head and thorax are not as dark as when the larvae are young. The few hairs that appear on the body are short, and pale in color.

Pupae. The pupa or resting stage of the insect appears never to have been described. All larvae used for wintering during 1918–1919 died, probably from lack of proper protection.

Adults. The adults of this insect are small moths about 5/16 inch long and a trifle less than ½ inch wide when the wings are spread. The moths are mouse-colored with but few conspicuous marks. The markings most easily noticed are 16 to 18 black and white oblique dashes along the fore margin of the front wings. These markings are rather inconspicuous toward the base of the wings but become quite distinct toward the tip. There is also, near the tip of each fore wing, a small spot not so easily noticed which has the same kind of dashes, but these are longitudinal and not transverse, as are those on the margin.

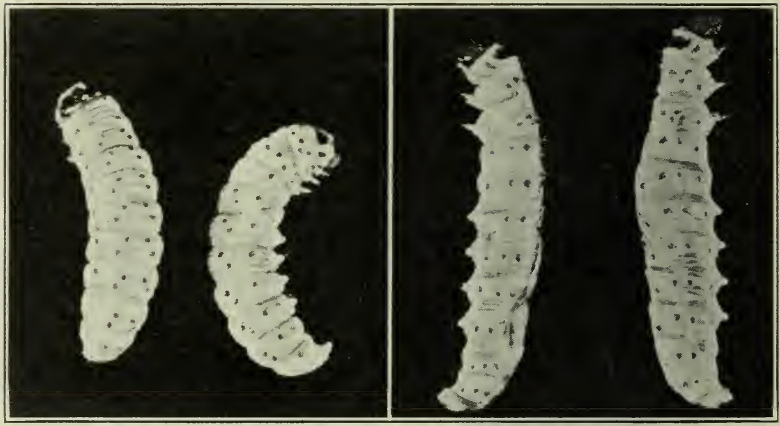

FIG. 3. READY TO GO INTO WINTER QUARTERS

The larvae of the pea moth grow rapidly and are soon ready to leave the pea pods. These are full grown larvae, natural size (about one-half inch long).

HOW THE PEA MOTH LIVES

The pea moth spends ten months of the year in its winter cocoon, the other two months it spends in activity near or on the pea plant. Practically the whole time during those ten months the insect is in the larval or worm stage and during this time neither eats nor grows. On maturing in the fall the worms leave the pea pods where they have been feeding, make their way a short distance into the soil, and construct a strong cocoon composed of soil particles, webbing and gluing them together, and then lining the interior with fine silky threads. Here they remain until late spring, when they change to pupae, later coming out as adult moths.

The moths begin to appear shortly after the pea vines start to bloom. The first moth to be captured in the field was taken July 14, the largest number July 18, and the last one July 30. The chart (page 11) illustrates the rapidity with which the moths emerge.

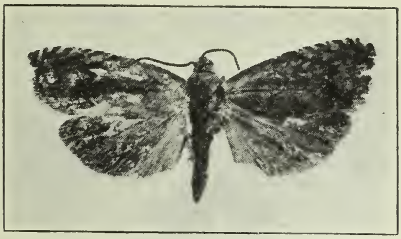

FIG. 4. AN ADULT PEA MOTH

The moths, which are frail and small, fly over the pea fields about sundown and lay their eggs on the vines or on grass or weeds close to the vines. The photograph shows the moth greatly enlarged.

Between 4 and 8 o'clock any quiet evening during the moth season, the adults could be seen flying about the pea vines. The greatest number were usually noticed about 6 o'clock. Moths were very seldom seen after sunset.

Their flight is of a zigzag nature but rather slow unless unusually disturbed, at which time they soon disappear from sight. Soon after depositing the last egg, the female moths die.

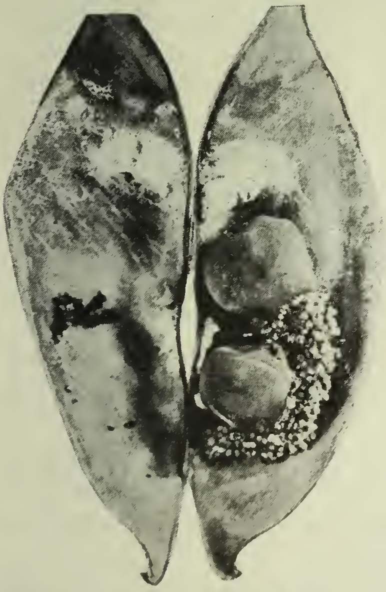

FIG. 5. THIS IS THE WORK OF THE PEA MOTH

Peas attacked by the moth are unfit for table use, ruined for seed purposes, and reduced in value for stock feed.

Usually the moths lay their eggs singly upon the pods (seldom upon very young pods), the leaves, the stems of the pea vines, or even on the stems and leaves of grasses or weeds growing in the pea fields. Only in a few cases was more than one egg laid in a place. The first eggs were laid July 17, and a maximum was reached within 2 or 3 days. Very few were oviposited after the first of August. The period between the time of laying and hatching varied from 7 to 10 days, depending upon the warmth or coolness of the weather.

The first egg hatched July

23, and hatching continued until August 13. These periods are illustrated in the accompanying chart.

Upon hatching, the young larvae seek suitable places to eat their way through the growing or ripened pea pod. The small larvae make a very tiny hole, and it is almost impossible to find the entrance holes after the cast-aside, chewed particles of the pod, called frass, are rubbed off or blown away. The young feed upon the peas within and grow rapidly, some completing their growth in 16 days, others requiring 26 days for development. Out of hundreds of pods examined in the field there were only a half dozen cases where there was more than one larva to a pod and in those instances there were only two.

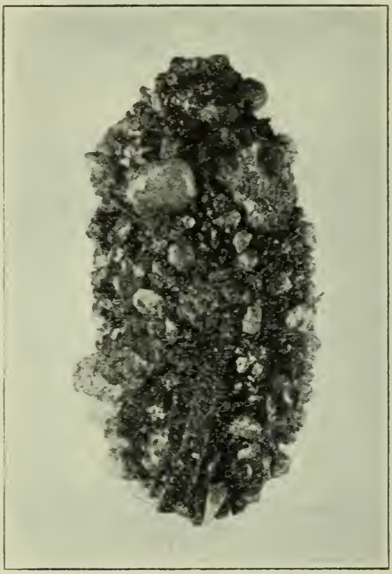

FIG. 6. WINTER COCOONS ARE USUALLY MADE IN THE SOIL

When the larvae are full grown they seek shelter by burrowing a few inches in the soil and there forming cocoons in which they spend the winter. The photograph shows the soil cocoon several times its natural size.

From one to all the peas in the pods attacked by the larvae were injured. When partly grown the young worm forms a kind of cocoon within the pods next to the peas, the peas forming one side of the cocoon. It is made up of the accumulated frass webbed together. The larva then continues feeding, making irregular holes and often devouring as much as half of each pea.

Infested pods are not easily detected. The only sure method of determining the presence of the worms is opening the pods. Infestation seems to hasten maturity of the pods and sometimes causes them to blanch prematurely.

As soon as the larvae are full grown, they leave the pods through small round holes and seek suitable wintering quarters. If the peas are still in the field, the larvae enter the soil a short distance and construct their cocoons, thus making ready for the winter season. It often happens, however, that the peas are harvested and placed in the mow ready for thrashing before the pea moth larvae are developed. In that case the worms on emerging find wintering quarters among the old pea vines, or in cracks, crevices, or other suitable places in the barn.

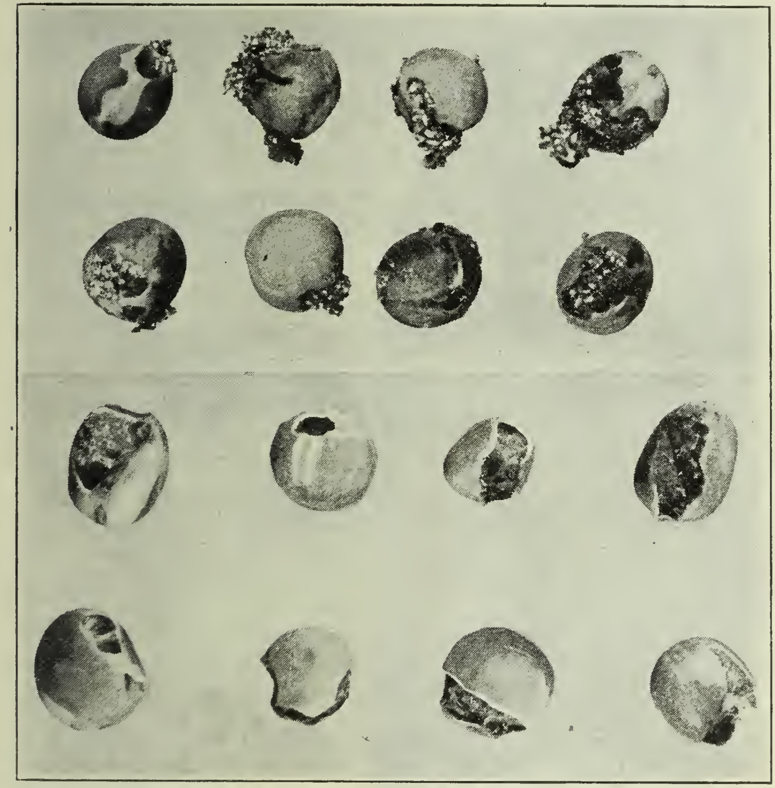

FIG. 7. PEAS BEFORE AND AFTER THRESHING

Before the peas are threshed the webbing and frass mark the presence of the pea moth. After threshing peas which have been injured show only where the larvae have been feeding.

WAYS TO FIGHT THE PEA MOTH

After only one season's experiments on the control of this pest, it is impossible to state definitely the best method to follow. Enough has been accomplished, however, to give a few recommendations. The various methods that suggest themselves and the value of each are taken up separately.

Trap light method ineffective. A trap light, fashioned after the Gillette light trap, was used for several nights during the season of flight of the moths. Very few adults of the pea moth were captured while other species of moths were caught in abundance. From this evidence, it seems that the pea moth flies very little after dark. The benefit derived from such a method would scarcely repay the time and expense of making the traps.

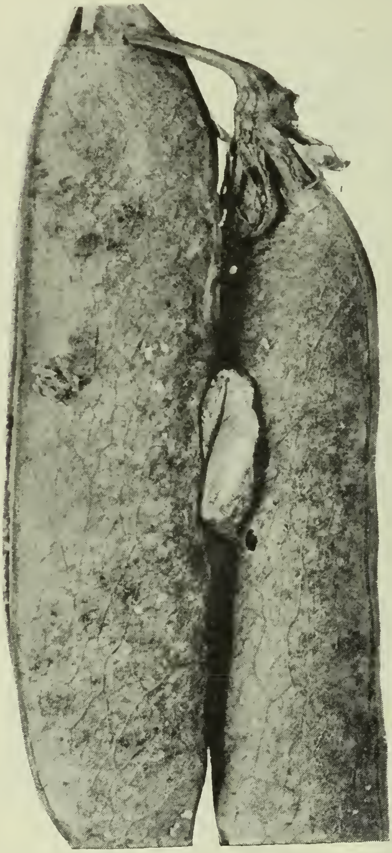

FIG. 8. COCOONS ARE OFTEN FORMED BETWEEN THE PODS

The small hole in the pod marks the place where the worm emerged. The worm is much larger than the hole it makes in the pod, but by squeezing its body through in sections it emerges through a hole only large enough for the head.

Spraying not successful. The present cultural methods used in growing peas and the nature of growth of the vines practically eliminate any possibility of controlling the pea moth by the use of poison sprays. Peas are planted broadcast so that the entire ground is covered with the vines. About the time the eggs of the pea moth begin to hatch and when sprays, if used, should be applied, the vines begin to fall over and mat together, which makes it impossible to cover all sides of the pea pods with a coating of poison. Another objection is that the pods increase in size so rapidly that several closely repeated applications would be necessary in order to keep the newly developed pods well coated with spray. The use of sprayed vines as a forage crop would also be a doubtful practice. All of these facts together with the damage done to vines in driving over the field two or three times very nearly eliminate the spray program.

Cultivate thoroughly, thresh early, burn rubbish. Pea moth larvae when they become full grown go a few inches into the soil where they spend the winter; thus, deep fall plowing will bury some of the larvae so that they will be unable to emerge in the spring. Thorough disking of the soil after the peas are harvested will probably kill some of the overwintering forms. But even these practices are not sufficient as many of the larvae do not leave the pods until after the peas are removed from the field. For this reason, if it is at all possible, peas should be thrashed within a day or two after they are harvested. By doing this, any larvae which have not yet left the pea pods would be killed when passing through the thrasher.

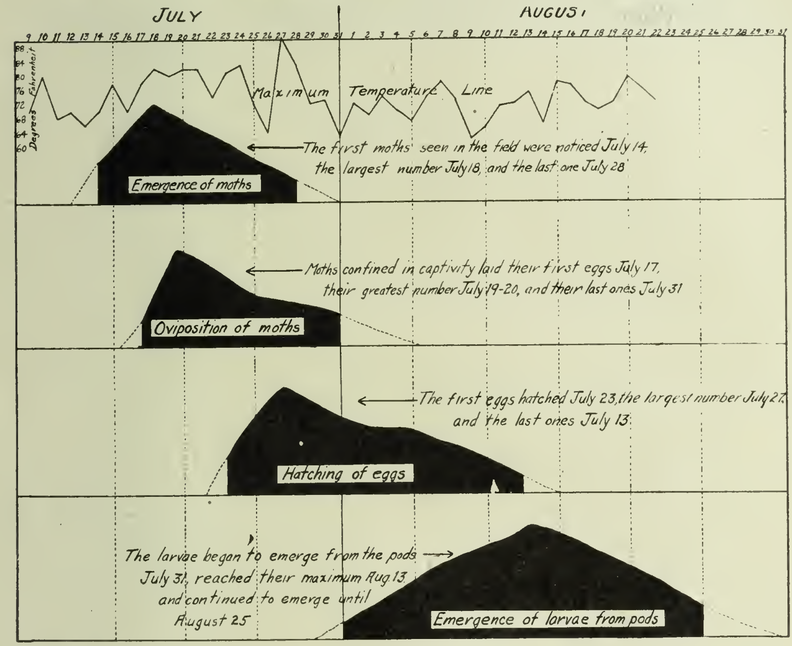

FIG. 9. LIFE HISTORY OF THE PEA MOTH, STURGEON BAY, 1919

The solid black indicates what was actually observed while the pea moth was in captivity. The studies were carried on in an outside insectary which was as near field conditions as possible. The dotted lines extending from the ends of the solid black indicate that activity of the insect probably covered more time than was oberved in the insectary.

It the straw remaining after thrashing is not to be used for forage or other purposes, it should be destroyed by burning. Any of the vines that have escaped the mower and remain in the field should be raked together and burned.

Select early-maturing varieties. Careful study of the life history chart shows that the eggs of the pea moth did not begin to hatch in 1919, until after the middle of July. If varieties are selected that will mature before this date the crop will escape the ravages of the pea moth. The best recommendations to be given at this time are:

1. Select the best early maturing varieties.
2. Plant as early in the spring as possible.

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